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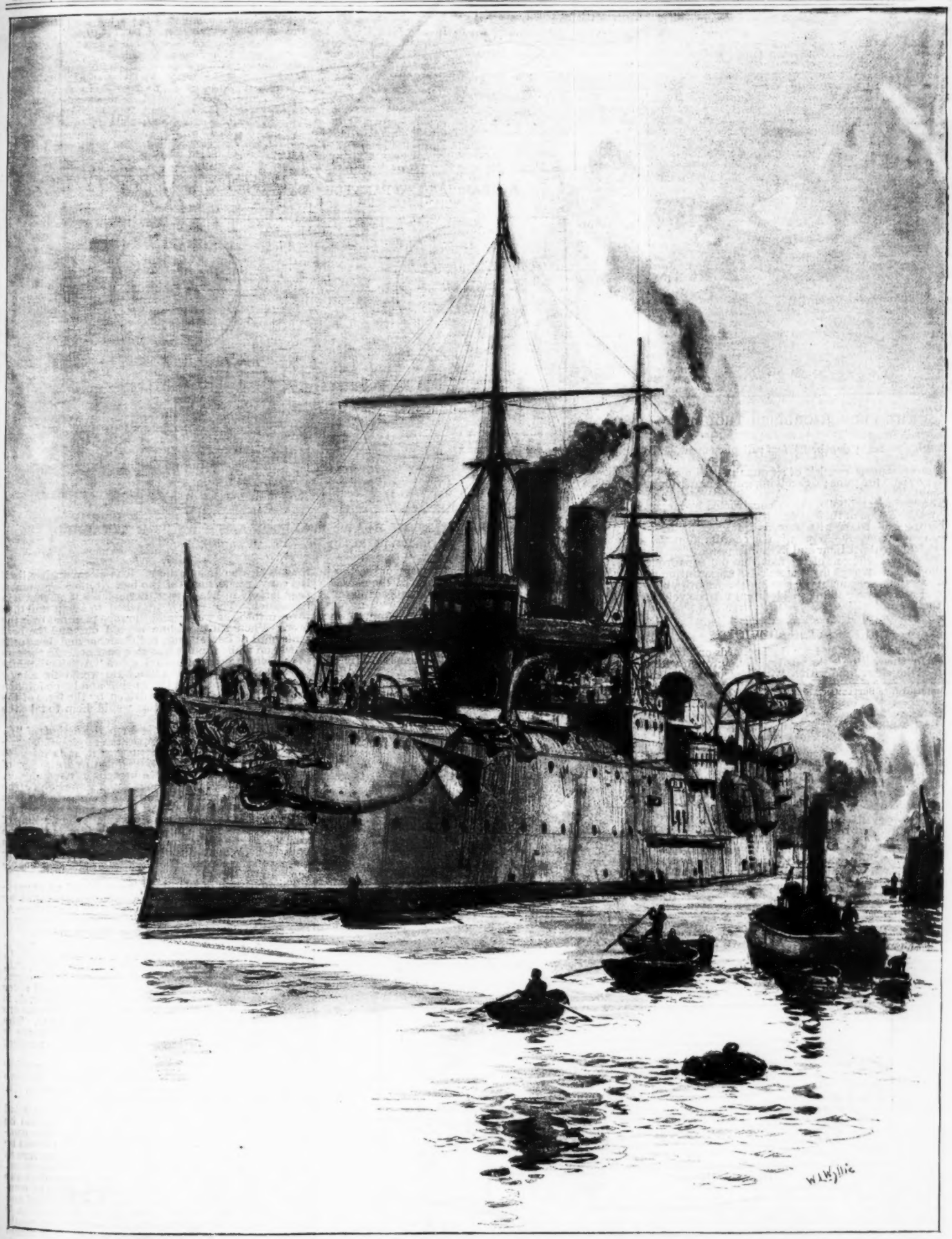


The Blenheim and her sister ship the Blake are the largest, fastest, and heaviest armed ships in the world. The displacement is 9,000 tons, length 375 feet, and beam 65 feet. The machinery is equal to 20,000 horse power, and will drive the ship at a rate of over 20 knots an hour.

H M.S. BLENHEIM, THE NEW FIRST-CLASS PROTECTED CRUISER, ON HER TRIAL TRIP. (Drawn by W. L. Wyllie, A.R.A., for the *Graphic*, London.)

THE CRUISER TROUDE.

THE cruiser Troude, constructed in the dockyards of Gironde, at Bordeaux, and the trials of which terminated to the entire satisfaction of the government, now forms part of the squadron of the Levant. Two other cruisers, having the same dimensions, were finished at the same time as the Troude—the Lalande and the Cosmao.

The dimensions of these cruisers are as follows: Length at load water line, 311 feet; breadth, 29½ feet;

THE FRENCH CRUISER TROUDE.

draught, 14 feet; depth, 22 feet; displacement, 1,877 tons.

The armament consists of: 4 guns of the model of 1884; 4 rapid fire guns; 4 revolving guns; and 4 torpedo tubes.

The engines and boilers were constructed by Messrs. Schneider & Co., at their Creusot works.

During the trials with forced draught the mean speed was about 19 knots, with a consumption of 2½ pounds of coal per hour and per horse power.

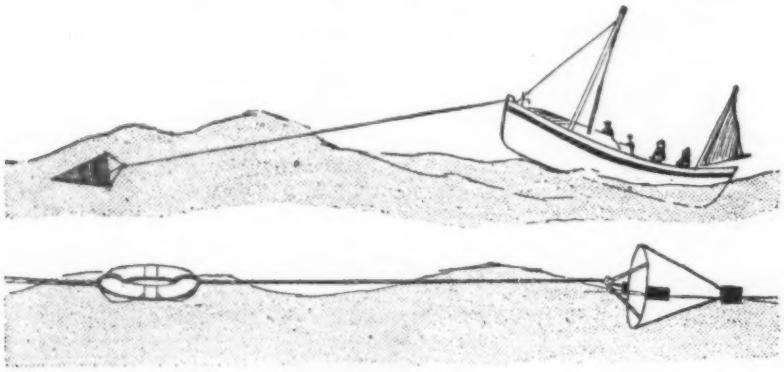
We are not ignorant of the fact that our squadrons, while being strong in armorclads, are wanting in cruisers that are capable of serving also as swift, light ships; and those under consideration fill the void in our naval *materiel*.—*Le Monde Illustré*.

LIFE SAVING DEVICES.*

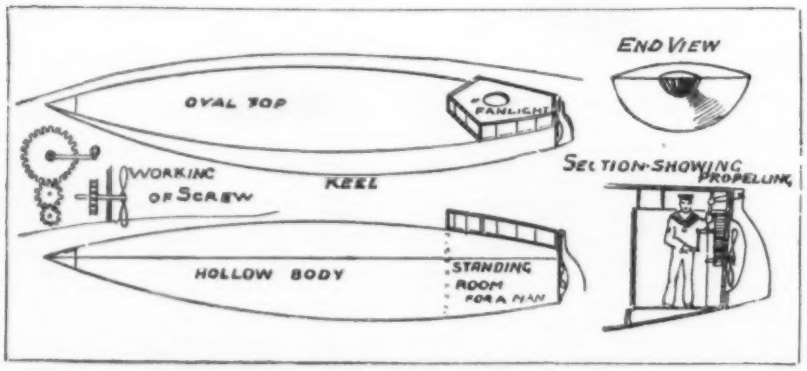
"A SAILOR," writing from St. Leonards-on-Sea, suggests in the case of a stranded vessel, aground within hail of the shore, and with a wind blowing off the sea such as would render the rocket apparatus useless in the teeth of the wind, a special use of the common ship's buoy, with a storm anchor attached, as indicated in the sketch below.

The sketch shows first a boat riding before a heavy sea, using a storm anchor to keep her head to wind; second, a storm anchor attached to the buoy ready for use. The square blocks at the side and end of the cone are pieces of coke, so that half the cone is out of the water and offers resistance to the wind. "A Sailor" says that the line must not be a heavy one, but it could be quite thick enough to haul a stouter one from the vessel when once ashore. The storm anchor itself is a canvas cone, made of the best No. 1 canvas, and is used largely in heavy seas by small boats, as shown in the sketch. The cone is attached to a line and then thrown into the water and the rope paid out over the bow. When sufficient line is paid out and the boat pulls hard at her anchor, both anchor and boat drift slowly on while the big seas ride past her. In the case of the cone taking a line on shore "A Sailor" thinks the effect would be the same. He would fix a buoy about six fathoms from the anchor and let go into the water. The cone would be driven by the force of the current ashore, and the buoy would help to take the weight of the rope.

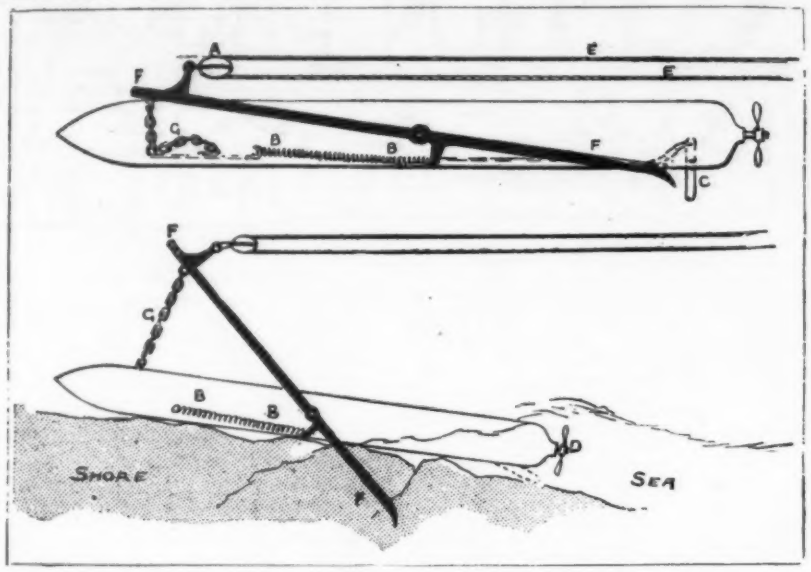
* Continued from SUPPLEMENT, No. 848, p. 13551. From *Daily Graphic*.



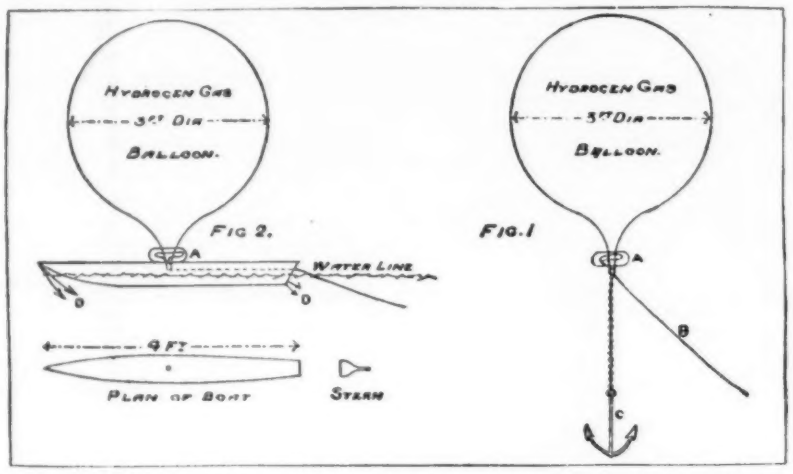
LIFE BUOY WITH STORM ANCHOR ATTACHED, AND BOAT RIDING WITH STORM ANCHOR. ("A Sailor's" suggestion.)



A BOAT TO CARRY A MAN ASHORE. (Designed by G. W., Walthamstow.)



A GRAPPLING APPARATUS. (Designed by C. H. W., Highgate.)



BALLOON WITH SHALLOW BOAT. BALLOON WITH ANCHOR ATTACHED.
(From designs by Mr. W. C. Richards.)

The sketch given below is from the designs of "G. W.," Walthamstow. The apparatus, as pictured, largely explains itself. In constructing it, it is intended that the top part shall be so designed as to be out of water, to enable a lookout to be kept by a man inside. The body would be made hollow and watertight. The inventor says he is sure the working and steering of it will be very simple, and will only require one person inside to work it. He does not explain the working of the apparatus very closely, but the idea is that one man should be in the stern of the craft working a series of cog wheels by means of a crank, these wheels giving motion to the screw. His position would also enable the man to steer.

The invention of "C. H. W." consists of an apparatus, such as is shown in the sketches, propelled by compressed air, like a torpedo. It is made thus: A, block with pulley; B B, springs; C, trigger to release the springs; D, screw propeller; E, line to ship; F F, grappling bars, one on each side; G, check chain. When the apparatus reaches the shore the trigger, C, is forced back; this releases the grappling bars, F F, which then press against the ground. If the ropes, E E, are then pulled, the points of the bars will enter the ground, while at the same time the block, A, is raised five or six feet above the sea level. The bars are prevented from going too far by the chain at G. The apparatus is intended for use in cases where there is no one on shore to receive a line fired from a rocket tube.

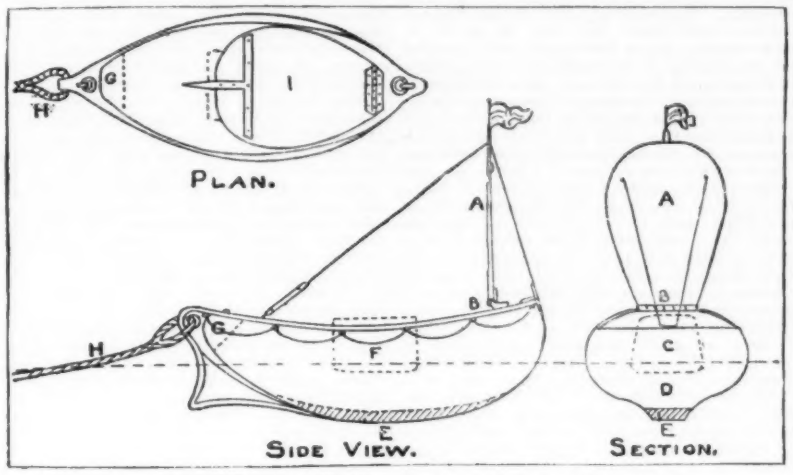
The idea of utilizing a balloon in one form or other has occurred to many of our correspondents. We give to-day a sketch, from a drawing by the inventor, Mr. W. C. Richards, of a design of this sort.

The design (Fig. 1) on the right is of a balloon filled with hydrogen gas, 3 ft. in diameter. At A would be an electric lamp, 6 in. by 3 in., and B is a cable composed of four wires, two to the lamp, and two would be extended to pass through the balloon and fire a fuse at its apex, which would destroy the balloon if necessary. C shows the anchor with chain. We gather that the electric light wires are intended to form a line of communication when the balloon has been exploded and the anchor has caught. The second design (Fig. 2) substitutes for the anchor a shallow boat, which would draw only two inches of water, and at D D would carry anchors to grip the land when it was reached. A is an electric light, and it is also intended to manage

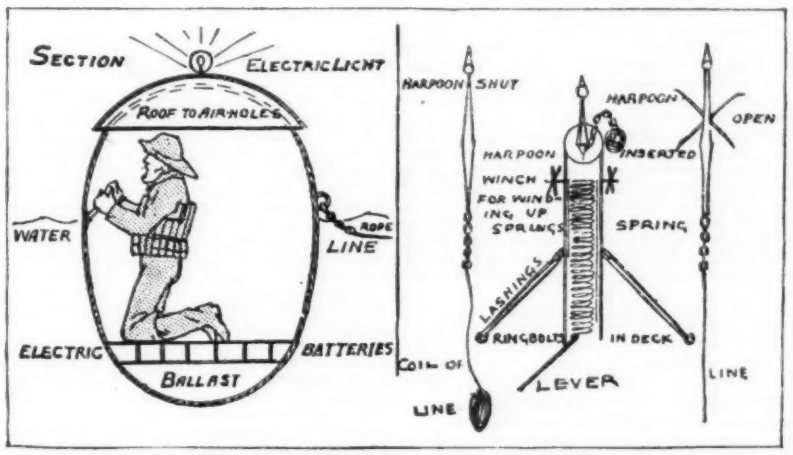
this balloon from the ship. No further details are given by the inventor.

Of the design sent by Mr. R. C. Leslie, which he calls a pilot life canoe, the sketches show plan, section, and side view. In the plan, I is a wooden wing stowed flat on deck, G is an oil tank, and H a coir rope. The side view shows A, the wing, upright, B the hinge by which it can be lowered, F a well room, G the oil tank, E lead, and continued on the keel band is a spur to act as grapnel. H the coir rope. In the section, A is the wooden sail or wing, B the hinge, C the well room, D middle section, E lead keel. The invention consists in a strongly-built "full-bodied little canoe," say of from 6 ft. to 10 ft. in length. It might be built of steel, having from two to three hundredweight of lead run into the keel, and be fitted with a strong light wooden wing or sail forward, as shown in the sketch, to be rigged up before throwing overboard. Longitudinally the canoe is bounded below by a strong iron shoe or band, developing abaft into a solid spur, to act as a grapnel to hold the canoe and the rope when ashore. "Such a boat," says the designer, "would be uncapsizable and unsinkable, and the line she towed would tend to keep her from turning end over end upon the crest of a wave. A small oil tank would also help to smooth her passage shoreward by allowing oil to slowly trickle out, and in a canoe of 10 ft. by 4 ft. a watertight well amidships could be arranged large enough to carry a hand ashore."

Mr. Blomfield's idea is almost sufficiently explained by the sketch. It is a cask-like buoy, the bottom divided into compartments, one containing ballast, the other cells to supply the electric light fixed on the top. On reaching the shore the man is to let himself out and establish communication with the ship by means of the line. The handle is to regulate the flashes of the light.



A "PILOT LIFE" CANOE. (Designed by Mr. R. C. Leslie.)



A CASK-LIKE BUOY TO CARRY MAN AND LINE ASHORE.

(From a sketch by Mr. W. Blomfield.)

A HARPOON WITH CORD AND BOMB TO BE FIRED FROM A GUN.

(From a sketch by Mr. J. C. Lawson.)

Mr. J. C. Lawson's invention is also very clearly understandable from the sketch. The intention is to fire the harpoon from a spring gun. The harpoon would carry a chain ending in a coil of ratline and a bomb would burst on reaching the ground, releasing the forks of the harpoon and fixing them in the shore. "In case," he says, "there was no person on the beach, fire a second line as near as possible to the spot where the first bomb burst, then rig the cradle on the first line and let the lightest weight and the stoutest heart haul himself ashore with the second line, and a stouter line can then be bent on."

RESINS, WAXES, AND SOLID PARAFFINS.*

By Prof. A. H. CHURCH, M.A., F.R.S.

IN commercial parlance resins are incorrectly termed gums. The true gums are either soluble in water or swell up in that liquid, but resins are not acted on by water. The term resin is used throughout the present volume in its proper sense, so that "copal resin," "mastic resin" are spoken of, not "gum copal," "gum mastic." All the resins used for making vehicles and varnishes are of vegetable origin, and are probably oxidation products of certain hydrocarbons in essential oils. Some resins, such as gamboge, contain gum and are called gum resins; others contain a hydrocarbon or an aromatic acid, and are called balsams; others are true resins, but even these rarely, if ever, consist of a single definite compound, but are mixtures of at least two, often of three, four, or five different bodies. Generally these constituents of true resins differ as to their degree of solubility in various liquids, such as alcohol, ether, spirit of turpentine, benzene, petroleum spirit, and heated fixed oils. They contain carbon, hydrogen, and oxygen, with occasionally a little sulphur, and are usually of an acid character, and are capable of forming soaps, called resinates, with the alkalies. Resins differ much from one another, not only in solubility but also in hardness and in the temperature at which they melt. Those which are least soluble are generally those which are hardest and which require the highest degree of heat to bring them into fusion. Most true resins contain, besides their proper resinous constituents, small quantities of coloring matter, of water, of crystalline aromatic acids, and of a volatile hydrocarbon or terpene. All these impurities, save the first, may be removed generally with advantage by the following treatment. The powdered resin is thoroughly mixed with a little water and placed in a large glass retort. A current of steam is then passed into the mixture until the terpene and volatile acids present have distilled over. To the contents of the retort carbonate of soda is added (1 part for each 100 of resin). The mixture after agitation is allowed to cool and then filtered through a fine cotton cloth. The purified resin is then washed on the filter with distilled water, then dried in the air and finally in the water oven; the air bath and a temperature of 110° to 120° C. may be used for the desiccation of the harder resins.

It might be thought that the subject of resins would be sufficiently discussed from the painter's standpoint by a description of three kinds—amber, copal, mastic. But it will be shown presently that copal and mastic are names given to several distinct substances, and that there are some other resins which cannot be excluded from our view.

Amber is the most familiarly known of all the resins, on account of its long use in its natural state for ornamental purposes. Amber beads have not infrequently been found in early British graves; on the Continent these and other ornaments of amber have often been obtained from ancient interments. At Naples I was shown some years ago a very large number of antique fibulæ carved out of this substance: they had just been disinterred from Etruscan tombs. Such amber has often become brittle, especially so far as regards the surface layers; but in other instances the preservation of the properties of this resin has been complete. The chief localities where amber is found are the Prussian shores of the Baltic Sea (particularly between Konigsberg and Memel) and the neighboring plains; it has been found in veins, and is regularly quarried. Some amber, much of it having a dark color, is found near Catania, Sicily. Near Lemberg (Galicia in Austria) nodules of amber occur in rock. It occurs in several places in Denmark, Sweden, Norway, and France. In the British Museum collection of minerals there is a fine mass from Cambridge. Excellent specimens occur in comparative abundance on the seashore at Southwold in Suffolk, and at several other places on the Suffolk, Norfolk, and Essex coasts. The dark fossil resin found in Burma, often in large masses, is probably not identical with Baltic and English amber. The same observation may be made with respect to the so-called ambers of Travancore in the East Indies and of the Isle of St. Louis, Senegambia, Africa. In fact, amber, instead of being, as commonly stated, the fossil resin of a single species of tree of Tertiary age, has obviously been derived from no inconsiderable number of different plants. Goppert, so long ago as 1853, satisfied himself that at least eight species of plants besides *Pinites succinifer* have afforded this fossilized resin; he also enumerated 163 species of plants as represented by remains in amber; many others have been since recognized.

Amber has a specific gravity of about 1·07; its hardness is 2½ on the ordinary mineralogical scale. In most of the usual solvents of resins it is either insoluble or but partially soluble. When heated quickly on a spatula it splits up and then fuses into a viscous liquid, the drops which are formed rebounding as they fall upon a cold surface; this behavior serves as a distinguishing test between amber and copal. When crushed amber is heated in a retort it fuses at about 280° C. (536° F.), gives off water, succinic acid, marsh gas, a mixture of liquid hydrocarbons (known as oil of amber), and, finally, at a very high temperature, a yellow substance having a wax-like consistence. Sulphureted hydrogen and other sulphur compounds are also evolved in small quantity, for amber, like several other fossil resins, contains a little sulphur (sometimes ½ a part in 100) in organic combination. Amber breaks with a conchoidal fracture. When fragments of amber are being ground or powdered they emit an aromatic odor. On being rubbed amber becomes negatively electric in a high degree.

It is probable that true amber consists mainly of a single resin (85 to 90 per cent. of the whole) represented by the empirical formula $nC_{10}H_{16}O$. Small quantities of two other resins which are soluble in alcohol and ether, of a liquid hydrocarbon, and of succinic acid are associated with the main constituent, which has received the mineralogical name "succinite."

The classical names for amber were *ἤλεκτρον*, *lyncurium*, *electrum* and *succinum*. In early mediæval times amber was called *vernix*, a term which at first was applied also to sandarac, and later in the fifteenth century to sandarac only, when amber was designated as *glas*, or *glassa*. In modern French amber is distinguished from *ambre gris* as *ambre jaune*. It is the *Bernstein* of the Germans. The word "amber" is probably derived, through the Spanish, from the Arabic *anbar*, a term applied to ambergris.

Copal is a name given to a number of hard resins which vary not only in their degree of hardness, but also in their degree of solubility: they are the produce of many different species and even genera of trees, while the origin of several of the kinds still remains unknown. One of the hardest, whitest, and best of all is known as Sierra Leone copal, from the port of collection and shipment. It has been identified as the resin produced by a tree, *Copaifera Guibourtiana*, which belongs to the sub-order Cæsalpineæ of the order Leguminosæ. It is probable that the hard West African pebble copal is the resin of the same tree, but it occurs in rolled pebbles with an abraded surface, and is at least semi-fossil: it is collected from the beds of streams. Pebble copal has more color than Sierra Leone copal, but yields as strong a varnish. The latter resin occurs in irregular rounded lumps or masses, generally varying in size from that of a hazel nut to that of a walnut. It is hard and elastic. It consists of at least two resins, one of which, present to the extent of thirty-three per cent., is soluble in absolute alcohol and in spirits of turpentine. The other resin constitutes nearly the whole of the remaining part of the copal and becomes soluble in most of the usual solvents, as well as in hot linseed oil, when it has been previously heated to its melting point or to a temperature of 180° to 221° C. (360° to 430° F.) Another process for rendering this and other kinds of copal soluble is reduction to a fine powder in the presence of water and the subsequent exposure of this powder to the air for several months or even a whole year. The time requisite for this change may be shortened by keeping the powdered copal at a temperature higher than that of the ordinary atmosphere.

Other species of the genus *Copaifera* yield similar but inferior resins to that produced by *C. Guibourtiana*, but *C. Gorskiana* is the source of Inhambane copal; Benguela copal, Angola copal, and Gaboon copal are other sorts, varying in hue from straw color to a dull reddish orange, produced in all probability by different species of *Copaifera*.

Zanzibar copal is another hard and valuable resin of African origin: it is often called anime. It is produced by another leguminous tree, *Trachylobium Hornemannianum*, which belongs to the same sub-order, Cæsalpineæ, as *Copaifera*. Most of this Zanzibar copal occurs in a fossil or semi-fossil state in the earth near the roots of the trees, or in places where the trees have formerly stood. This fossilized resin is covered when dug up with a semi-opaque, rough, and dull brown crust; when this powdery coat is removed the remainder of the mass appears of a transparent yellow color, with a surface covered with small rounded elevations like those on the rind of an orange: this is spoken of as "goose skin." Many of the pieces are flat and tabular, with a thickness of a quarter of an inch or more. The same resin, when occurring on the bark of the living trees of the same species of *Trachylobium*, presents a smooth and glossy surface; it is not so hard as the fossil variety. Zanzibar copal melts at a higher temperature than Sierra Leone copal, and is very hard. In order to render it soluble it may be treated in the same manner as the Sierra Leone copal. Its chemical nature requires further study.

A third resin, sometimes designated as copal, sometimes as anime, is produced by another leguminous tree, *Hymenæa courbaril*, a native of Brazil and other countries of South America. It is rather softer and more soluble than Zanzibar copal. The copal of Madagascar comes from another species of the same genus, *H. verrucosa*. A Mexican copal is probably the resin of an allied species. The resin from *H. courbaril* is generally known as West Indian copal: fine specimens have been received from Demerara.

The bungo tree of Sierra Leone, *Daniellia thurifera*, affords a resin of inferior quality. It is probable that

*Abstract from the Chemistry of Paints and Painting, by A. H. Church.

the same leguminous tree is the source of some of the Niger and Soudan copals.

A rather hard resin of comparatively recent introduction is kauri or cowdi copal, produced by the cowdi pine of New Zealand, *Dammara australis*. This is a coniferous tree belonging to the tribe Araucarieæ. The largest masses, some of them occasionally over 100 pounds in weight, are found in the earth in many places far from those in which the trees now grow. Kauri resin usually becomes more transparent and yellower by keeping. It is generally somewhat whitish, or streaked with opaque bands, when first found. It is cleaned and scraped and then sorted into several qualities. Its use has greatly extended of recent years. It is now largely employed as the basis of most of the so-called copal varnishes, on account of its abundance, its low price, and its easy manipulation. But the varnish which it yields is inferior in hardness, toughness, and durability to that made from Sierra Leone copal or Zanzibar copal.

Kauri resin is sometimes spoken of as dammar, but this name properly belongs to the resins produced by other trees, not by *Dammara australis*. White or Singapore dammar is the resin of *Dammara orientalis*. It is soft, and may be scratched even by mica. "Sal-dammar" is produced by *Shorea robusta*, the sal tree, widely distributed in India. This resin, though soft, yields a good flexible paper varnish. The tree belongs to the Dipterocarpeæ. *Vateria indica*, another Dipterocarp, yields piney resin or white dammar; a similar resin is produced by another species, *V. acuminata*, a Ceylon tree. Several kinds of *Hopea* (*H. micrantha*, *H. odorata*, etc.), which belong to the same natural order, yield pale, transparent resins which are a trifle harder than that of the sal tree. Black dammar or Tinnevelly resin is produced by *Canarium strictum*; it is of very inferior quality. This tree belongs to the Burseraceæ. Several kinds of elemi resin are also furnished by plants belonging to the same natural order. These elemis are soft, sticky resins, occasionally employed in varnishes to prevent them from becoming brittle and cracking. They contain essential oils and other aromatic bodies, and vary very much in composition and properties, although they resemble one another in their solubility in boiling alcohol and in their easy alterability. They are unsatisfactory resins.

The resin first known as sandarac was probably juniper resin, although the name was also applied to amber. It is spoken of by the older authorities on painting as having a red color. Its hue is a dull reddish orange, and it yields a dark brown varnish when dissolved by the aid of heat in a drying oil. The effect of this varnish in imparting an agreeable warm tone to pictures painted in tempera is very evident, when the cold aspect of an old Italian unvarnished tempera picture is compared with the glowing color of a painting which still retains its original sandarac varnish. The resin now called sandarac is produced by another coniferous plant (*Callitris quadrivalvis*), a native of Algiers. It is a pale yellow resin, when fresh resembling mastic in color, but becoming yellower with age. It is soft and brittle. When finely powdered and sifted it forms one of the kinds of pounce used in preparing the surface of parchment and vellum for writing and illuminating. It melts at 130° C. (266° F.), exhaling an aromatic odor. It partly dissolves in alcohol, and is wholly soluble in oil of spike and in several terpenes; acetone also dissolves it.

There is one more resin which requires mention. This is mastic. The best and most important sort of mastic is produced by a small tree (*Pistacia lentiscus*), belonging to the cashew nut order or Anacardiaceæ. This tree occurs in Scio and other islands of the Greek Archipelago. Mastic exudes in the form of tears from incisions made in the bark. It occurs in small pea-like masses, and presents when fresh a very pale straw color. It is so fragile that it may be crushed to powder between the fingers. It has an aromatic odor, and dissolves completely in boiling alcohol and in spirits of turpentine. Its melting point is low. It contains, besides its resinous constituents, a small quantity of a volatile essential oil (a terpene) and of moisture. It yields a tender but glossy varnish, largely employed for the final protection of pictures in oil. This varnish yellows with age, and becomes fragile and fissured.

Resins, sometimes called mastics, are produced by other trees of the same genus. These resins, which are of no value for artistic purposes, are:

Indian mastic from *Pistacia cabulica*.
Bombay mastic from *P. khinjak*.
Pistachio mastic from *P. terebinthus*.

Wax.—The true waxes, unlike the oils, are not glycerides, and do not therefore yield glycerin when they are saponified—that is, turned into soaps by the action of alkalies. Ordinary beeswax is the best known, and probably the most important of all the different kinds; but very few experiments have been made as to the utilization of exotic and vegetable waxes in the processes of painting. Crude beeswax requires purification and bleaching in order to fit it for artistic use. The first operation consists in melting the wax at nearly the lowest temperature possible, and then pouring it in a slender stream into a cold saturated solution of alum, agitating the latter all the time. The granulated wax thus prepared may be bleached by exposure for several days on linen cloths to the action of the sunlight and dew; or it may be treated with dilute chromic acid solution, or with hydrogen peroxide. All these processes succeed better when the wax is in the form of thin sheets or ribbons. The bleached wax, after thorough washing and drying, is to be remelted. Its hardness is increased and its melting point raised by the above treatment.

Bleached beeswax melts at 62° or 64° C. (144° or 147° F.) It consists of four distinct substances, not present in all samples in the same proportions. By boiling wax with strong alcohol a substance called myricin (myricyl palmitate) is left undissolved. The dissolved portion is the larger; the bulk of it, which crystallizes out as the alcohol cools, was formerly called cerin. It is a mixture of two fatty acids. The cold alcohol still retains a small quantity of a fourth substance.

Beeswax, by long-continued exposure to atmospheric influences, disintegrates and partially perishes by oxidation. It is a constituent of Gambier-Parry's spirit-fresco medium, into which it is introduced in order to impart a matt appearance to the painting. Excellent examples of the use of melted wax as a binding material for pigments may be seen in the National Gallery and the South Kensington Museum. They are *encaustic* portraits, executed probably in the second and third centuries of our era, and were discovered by Mr. W. M. Flinders Petrie, in the Hawara Cemetery, Fayum, Egypt. The pigments were mixed with wax and laid on in the melted state. The wax having become disintegrated in the course of centuries, has been remelted, some fresh wax having been added in several instances.

Wax is abundantly distributed in the vegetable world; its production is, in many cases, stimulated by the attacks of insects. Thus, Chinese wax is produced by the puncture of Coccus pela, living on *Ligustrum lucidum* and *Fraxinus chinensis*. Chinese wax, which melts at 82° C. (180° F.), consists almost entirely of cerotyl cerotate. Brazilian or Carnauba wax occurs naturally in thin films on the leaves of a palm (*Copernicia cerifera*): it melts at 84° C. (183° F.) Japanese or Ibota wax is probably produced by the attacks of a coccus on *Ligustrum Ibota*; it melts at 42° C. (108° F.)

Paraffin wax, hard paraffin, and solid paraffin, are names given to certain mixtures of hydrocarbons occurring in native petroleum and in the "mineral wax" called ozokerite, and also in the tars produced by the destructive distillation of wood, peat, lignite, bituminous shales, and coals.

Paraffin wax contains no oxygen, and is a mixture of several of the least alterable of all organic compounds; very few chemical reagents have any action at all upon it. On this account it presents for artistic purposes a marked superiority over beeswax or any vegetable wax. Of the hydrocarbons occurring in large quantity in paraffin wax the best known are those to which the chemical formulæ $C_{22}H_{46}$, $C_{24}H_{50}$, $C_{26}H_{54}$, $C_{27}H_{56}$, $C_{28}H_{58}$ and $C_{30}H_{62}$ belong. The melting point of paraffin wax oscillates within wide limits, say from 30° to 80° C. The higher the melting point the harder, the heavier, and the less crystalline is the material. For artistic purposes, hardness and the absence of a tendency to separate from solution in the form of large crystals are desirable properties. Unfortunately the hardest paraffin waxes of high melting point are much less soluble in oils, terpenes, and varnishes than the softer varieties, and thus their usefulness is limited; they are also somewhat yellowish in hue. I have, however, found that a pure paraffin wax from the Bathgate shale, having the melting point of 65·5° C. (150° F.), answers every purpose. It is sufficiently hard and but indistinctly crystalline, and yet may be dissolved in fair abundance by the usual solvents. It is convenient to preserve it for use in the form of small flattened globules, which are easily prepared by melting the substance and pouring it drop by drop on to the surface of a large sheet of glass previously moistened by breathing upon it. When these drops are shaken in a bottle they rattle like small pebbles, and do not mark the glass; when the softer solid paraffins are thus treated, they fall with a thud, and leave streaks and spots upon the interior surface of the vessel. This difference of deportment affords a ready means of distinguishing between a paraffin wax suitable for artistic uses and one which had better be rejected.

The manufacture or isolation of hard paraffin and its purification are not described here. The processes employed—distillation, treatment with oil of vitriol, fractional crystallization from solvents, etc.—involve the use of complex apparatus. It may, however, be here stated that commercial hard paraffins vary somewhat in purity. Those obtained from mineral wax or ozokerite are nearly free from oxygen compounds; while those derived from the products of the destructive distillation of shales, coal, etc., sometimes contain as much as 3 per cent. of oxygen, indicating the presence of other bodies besides hydrocarbons. Some of these bodies are of an acid nature; these may be separated by repeatedly boiling the commercial paraffins in question with a 5 per cent. solution of caustic potash. The following table shows the relations subsisting between the melting point and the specific gravity (at 20° C.) of six different samples of hard paraffin from ozokerite:

No. of Sample	Melting Point	Specific Gravity	No. of Sample	Melting Point	Specific Gravity
1	56° C.	0·912	4	72° C.	0·935
2	61°	0·922	5	76°	0·939
3	67°	0·927	6	82°	0·943

Hard paraffin wax may be used in the preparation of painting mediums as a substitute for beeswax; for preventing the separation of heavy pigments, such as vermilion, from the oil in which they are ground; and for the preparation of certain painting grounds.

DIFFERENT METHODS OF TINNING.

THE following letter on different methods of tinning has been addressed to the *Iron Age* by Mr. Hopkin Thomas, of Cleveland, Ohio:

I receive a great many inquiries concerning the difference between the palm oil tinning process, the acid flux process, and the old method of tinning, and with your permission I would like to make a general answer and explanation of these methods through the columns of your paper. In the old method of tinning tin and terne plates five pots were required to do the work. After the plates were pickled and washed in water and ready for tinning, the tinman would place them one by one in the first pot, which was filled about three-fourths full with palm oil, and he would put in this pot about 175 or 224 sheets of 14 × 20 plates, or twice as many 10 × 14 sheets. Next he would place them all in the tin pot, and after the plates had sunk down in the tin he would skim back the oil. The next step would be to take them out of the tin and give them to the wash man, who would place them in the wash pot, the latter consisting of two pots. The wash man would take about twenty sheets from the wash pot and brush and dip them in the clean pot and place them one by one in the palm oil pot, which had boiling palm oil in it. In this there was what we called a grate with pins so arranged as to keep the sheets separate in the oil. When the grate was full the boy would take them out one by one, and call out the number of pins, so that the wash man would know the empty pins. The sheets would be placed in rack separately, and as soon as the tin upon them had hardened another boy would take them one at a time and dip the edges in a little tin pot that had two iron bars, so that the sheets would not go any deeper than ¼ inch. This pot was called the list pot, and was used to take the tin off the edges of the sheet. After the plate had been dipped in the list pot the boy would strike it with a flat piece of wood. All the old method plates had a list on them. By this method plates would carry from 4 to 4½ lb. of tin on coke plates and 7 or 8 lb. on charcoal, while the terne plates would carry some 14 lb. of coating. The output by this method was 20 to 25 boxes per shift or turn.

Now, the demand for tin and terne plates increasing faster than the capacity to turn work out, necessity, as is often the case, became the mother of invention. At this stage of the trade two parties devised two patents for finishing tin and terne plates. One was the Cookley two-roll machine and the other the Morewood three-roll machine. The two patents coming out together resulted in a lawsuit, which was compromised. A little later Morewood brought out an improvement on his machine, using five instead of three rolls. In both of these processes the plates were tinned the same as in the old method, the only difference being that they were finished through rolls that worked in boiling palm oil, these rolls doing away with the necessity of listing the plates. For a while after the processes came into use it was customary to put about 3½ lb. of tin on coke plates and about 6 lb. on charcoal, and the output was a good deal more. Tin plate manufacturing was then a very profitable industry, and people were going into the trade all the time. At last, as competition became keener, it was necessary to devise a plan to make plates still cheaper. Many methods were tried, such as Morewood's complete flux pot and round flux pot, and many others, but they were all discarded before long. It was a well known fact that the shorter time the plates were left in the tin, the less tin remained on them; also the slower the speed of the rolls in the palm oil, the less tin there was on the plates. It must be borne in mind that the object sought after was a cheap charcoal plate.

The following is the system adopted in Wales now, with few exceptions. The first pot is the same as in the old method, holding the palm oil. The tin pot is somewhat smaller, so that only 20 or 25 coke plates are tinned at a time, the plates not being kept in the pot. After the 20 sheets are tinned the tinman raises them out and places them in what we call a soaking pot, which answers the purpose of the wash pot in the old method. After this the plates are worked through the rolls as in the other method. With this plan they have succeeded in coating coke plates with less than 2½ pounds of tin a box. In some instances, with two Morewood rolls in the palm oil pot, they have brought the coating under 2¼ pounds per box. When I refer to 2¼ pounds of tin, I mean that is the total amount, including waste and everything. Even this did not satisfy all the manufacturers, and if we can believe them they can coat plates with less than that amount, the Edwards machine, it is said, saving ½ lb. of tin per box, which would bring the coating down to 1¾ lb. of tin, including waste. The Edwards machine has only one pot, the tin pot and the palm oil pot being in one. Morewood's rolls are used in the palm oil pot, but acid flux is used instead of palm oil to do the tinning with. With a few exceptions, two rolls are used in making terne plates.

THE CHEAP PRODUCTION OF HYDROGEN GAS.

A WRITER in the *Gas World* says that hydrogen gas in a pure state is admitted to be an element of vast use in the arts in various branches, especially as a means of producing the greatest known heat procurable in the whole range of furnace chemistry. It is also of paramount importance as a material which, owing to its chemical affinities, is capable of reducing all, or nearly all, the natural oxides of the metallic substances of which the earth is composed, which carbon and other combustible fuel cannot reduce to the metallic state. The difficulty attending the use of hydrogen in the arts has been, and is, the expense and inconvenience attending its manufacture.

Up to recently the only method employed to produce hydrogen for experimental and sometimes balloon purposes has been by decomposing dilute sulphuric acid by iron or zinc. This method is both slow, operose, and very expensive, and is not adapted, under any circumstances, to the production of hydrogen in quantities other than for laboratory purposes and small experiments. By this method it requires 28 lb. of iron, or 32 lb. of zinc, dissolved in 40 lb. of sulphuric acid, to produce only 1 lb. of hydrogen or about 200 cubic feet at 60° Fahr. and 30 inches barometer. Therefore the cost per pound could not be less than from 62½ cents to $1.25, according to the material used, without taking into consideration the cost of manipulating bulky and expensive apparatus necessary; or from $6.25 to $12.50 per thousand cubic feet.

A newly patented method can now produce this valuable gas in any quantity at under 12 cents per thousand cubic feet, or 2¼ cents per lb. At this low price hydrogen fuel will become an important, practical, and commercial factor in the reduction of metallic oxides which, though common in nature, cannot now be converted into the metallic state by any application of carbon heat. Aluminum, calcium, magnesium, silicon, boron, and many substances are among those materials which, though most valuable in the arts, could not hitherto be obtained without the intervention of the expensive elements of sodium, potassium, chlorine and fluorine.

The new process is based on the well known reaction that when a current of steam is passed through melted iron it is decomposed, and sesquioxide of iron is formed at the expense of the oxygen of the steam, and the hydrogen is given off in the free and pure state. This can either be collected or at once used.

The oxide of iron left in the receptacle is then, while still hot, subjected to a current of hydrocarbon vapor from refuse petroleum or tar, which reconverts the oxide of iron into the metallic state for a fresh operation with steam to produce hydrogen again, without loosing, or indeed even moving, the iron in the receptacle. The hydrogen is thus obtained wholly at the expense of the petroleum or tar, which can be obtained at a cost of from 2 cents to 3 cents per gallon, and in some cases even lower prices.

One gallon of refuse oil or tar, by this pretty reac-

tion, is capable of yielding 500 cubic feet of hydrogen, or about 2½ lb. This seems strange, as the refuse oil does not contain 2½ lb. of hydrogen, but it must be remembered that the carbon in the oil vapor performs its full share in reducing the iron oxide to the metallic state, to be again oxidized by the steam current, producing hydrogen.

The apparatus for carrying out this process is very simple. It consists of any number of crucibles, say six, of about 4 cubic feet capacity, and having covered tops. These are an article of commerce, and will hold from 16 to 18 cwt. of melted iron. They are each provided with two fire-resisting tubes, which descend through the cover to the bottom, one for the conveyance of the steam and the other for the conveyance of the hydrocarbon reducing vapor in the alternating reduction of the iron oxide. These are set in the holes or arches of a glass pot furnace, either Siemens-Martin or other type. These pots when at the necessary heat are filled with molten iron, and steam from a boiler passed through the iron, until its decomposition no longer takes place; or, in other words, until all the iron is converted into sesquioxide. The valve in the hydrogen connecting pipe, which proceeds from the cover of the crucible to the gasholder, is closed, and the branch escape pipe opening into the flue is opened. The hydrocarbon vapor produced from a spray gas-generating chamber (too well known to require description) is then conducted through the heated iron oxide until the whole is reduced again to the metallic state; in the meantime the carbonic oxide and vapor of water escaping by the branch leading pipe into the flue. By the closing of the branch escape pipe and the opening of the hydrogen collecting pipe, cutting off the hydrocarbon vapor, and turning on the steam, the production of hydrogen again commences, and continues until the iron in the crucibles has again been fully oxidized.

It will be seen that the whole operation is automatic, with the exception of turning on and off the necessary connections, and the iron in the crucibles need never be moved or changed for years. The iron acts merely as a carrier, and does not waste. There is very little manual labor attending the working of the process, which can be alternating continuously.

A battery of six retorts of the size mentioned—three always making hydrogen and the other three undergoing reduction, and allowing two hours for the oxidation stage and two hours for the reduction stage—would produce about 50,000 cubic feet of hydrogen per hour. A 35 horse power boiler would supply ample steam for the whole apparatus. The vaporizer for the hydrocarbon vapor production should have a capacity of converting 110 gallons of oil per hour.

By a modification already schemed out, the retorts can be heated by petroleum blow-pipes, which renders the whole manipulation quite automatic, beyond the attention to the valves and connections, and the pumping up of the liquid hydrocarbon and the water for the boiler.

A SINGULAR CLOCK.

THE "Description of the Cabinet of Mr. Grollier, of Serviere," which we recently spoke of *apropos* of lathe work, contains an entire chapter devoted to clocks, several of which are remarkable for the ingenuity displayed in the construction of the escapement. The one that we are about to describe, on the contrary, is distinguished by the simplicity of its motor, which is nothing more than the weight of the clock itself. Fig. 1 is a fac-simile of the engraving accompanying the following description: This clock consists of a cylindrical box, which, being placed on the side of its curvilinear surface upon an inclined plane, seems to hold itself immovable thereon, contrary to the nature of round bodies, which usually roll with precipitancy as soon as they are placed on a slope. The box in question descends upon its inclined plane, imperceptibly and in measure. The hours are inscribed on the side of this inclined plane and on the circumference of the box, which is provided with a double hand that always stands perpendicularly and that marks the hour at two different points.

The mechanism of this ancient clock is not described, but it is easy to reconstruct it. A homogeneous cylinder placed upon an inclined plane is attracted by a force OA (Fig. 2, No. 1) equal to the projection of the

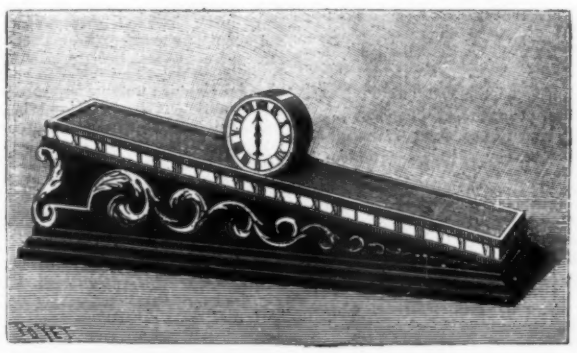


FIG. 1.—A CURIOUS CLOCK OF THE EIGHTEENTH CENTURY.

weight, OP, of the cylinder upon a parallel to a plane, and applied at the center of the axis of the cylinder, which it tends to make revolve around the point, B; but the same is no longer the case if the body is weighted on one side or the other. If, in particular, we fix to the cylinder a sufficient weight on the upward side, such weight will be capable of making it ascend until it assumes its position of equilibrium, which will be reached when the cylinder's center of gravity is situated in the vertical of the point of contact.

Again, let OP (Fig. 2, No. 2) be the weight of the cylinder, and O'Q the additional weight fixed at O. Let us place O'Q upon the line OP, and *vice versa*, and then let us join O'Q', OP'. The point of intersection of these lines evidently gives us a point of the vertical RS, which in the position of equilibrium passes through the point of sustentation.

Let us suppose, now, that the weight, Q, lowers in describing an arc of a circle around O. It will approach the vertical passing through the center, and the line, RS, will displace itself toward the right. It will fall downward from the point of contact, and the cylinder will roll until the weight has returned to its first position. Let us apply this principle to our clock. We fix (Fig. 2, No. 3) to the axis that supports the hand a rod, which is at right angles to it, and at the extremity of which there is an appropriate weight. This latter causes the axis to revolve in the direction O'T; but the axis, O, is provided with a gearing which, through various transmissions, ends at an escapement,

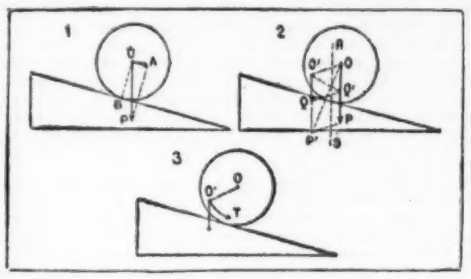


FIG. 2.—DIAGRAMS EXPLANATORY OF THE CLOCK.

and is capable of revolving only with a perfectly determinate velocity. The cylinder thus descends with its dial, while the weighted hand passes over it in a direction contrary to that of its motion.* The escapement of this clock, in fact, is of the nature of those called "tourbillon," that is to say, whose support itself revolves in order to annul the slight irregularities of its construction. Here we have once more a truth of the saying, "There is nothing new under the sun." It is very easy, moreover, to so transform this clock that the dial shall be stationary and the hour hand movable, the minute hand receiving its motion from the axis of the first through a back-acting wheelwork. In order to "wind up" the clock, so to speak, it suffices to put it at the top of the inclined plane again. As for simplicity, it would be impossible to wish for anything better.—*La Nature.*

GLAZING OR LUSTERING BODIES.

FINISHING materials of this kind are mainly added to stiffening compositions to increase the luster or gloss of the finished cloth, and at the same time to make this gloss more permanent. A few enable this gloss to be obtained without making the cloth too stiff and hard, and among these may be reckoned soap, oils, fats, wax, paraffin, and spermaceti.

Soap has already been considered; in addition to acting as a softener, it assists in the glazing of the cloth.

Tallow.—This fat is occasionally added to finishing compositions, partly to give suppleness to the cloth and partly to help in the glazing. It is the solid fat of the sheep and oxen, and we usually understand by the word the grease obtained from the omentum or skin, and from the fat surrounding the muscles and bones of the animal. It is, however, obtained from other parts, bones, feet, stomach, etc., but this is of very inferior quality to the tallow proper, although tallow melters are not above offering it when occasion serves. For finishing, when used as a glazer, the best hard beef or mutton tallow should only be employed; for softening purposes any good white tallow may be used. Good tallow is hard at 60° F., melts at 97° to 120° F., and solidifies at a few degrees lower. It is apt to grow rancid, but the purer the tallow the longer it will keep. Common qualities of tallows frequently contain traces of nitrogenous animal tissue, and this, decomposing, causes the tallow to become rancid much easier than if it were absent. Where it is not desired to use a deliquescent softener, tallow or other fat is a convenient medium for softening down the harsh feel of a starch-finished cloth. Bone tallow and tripe tallow are used because they are cheaper than ordinary tallow, but they possess an unpleasant odor, which is apt to be communicated to the cloths. If, however, care be taken in refining them, so that they are free from odor, they can be used in place of tallow.

Cocoanut Oil.—This fatty matter is got from the fruits of the cocoa palms, *Cocos nucifera* and *Cocos butyracea*. These nuts contain a large quantity of oil, extracted by pressing and boiling the fatty pulp of the nuts after breaking them open. It is a soft, white fat, melting at from 70° to 80° F. to a water-white oil. It has a peculiar odor, and if used in large quantities this may become communicated to the cloths. Sometimes the common qualities contain vegetable matters, which make them grow rancid quickly. Thorough washing with water frees them from this impurity. It mixes well with starch size, especially with sago size, better than any other fat, and owing to its pure white color is largely in request with finishers. It enters into the preparation of tracing cloths. It makes a good firm white soap, and gives a smoother, softer feel to cloth than tallow or bleached palm oil.

Palm Oil.—This fat is obtained from various species of palm trees, especially the *Elœis guinensis*, and from the fruit of these it is obtained as an orange buttery mass, in which form, however, it is not used by finishers on account of the color. It can, however, be bleached by many processes, forming a white, hard fat closely resembling tallow, but having a peculiar pleasant odor of violet. It can be used in place of tallow, its properties being identical. Other oils and fats, although occasionally used, do not require mention here.

Beeswax.—This substance is well known to every person as the product of the insects belonging to the bee family. Naturally, it has a bright yellow color, is rather granular in appearance, soft, easily marked with the finger, melts at about 145° F., and has a peculiar, pleasant odor. In this form it is not used in finishing, but it can be bleached; it is then known as white wax. It is sold either in small round cakes or large flat square blocks. Beeswax is a mixture of two bodies, 12 per cent. of cerotic acid $HC_{27}H_{53}O_2$ and 88 per cent. of myricyl palmitate $C_{30}H_{61}C_{16}H_{31}O_2$. It is insoluble in water, lighter than that body, dissolves in hot alcohol, but part of it—the cerotic acid—settles out on cooling. It is not saponified by aqueous solutions of caustic alkalies, but alcoholic solutions gradually saponify it; the soaps thus produced are not readily soluble in water and the alcoholic body that is formed is quite insoluble. It is used in finishing to enable a high degree of gloss to be given to luster finishes. Too much must, however, not be used, as the wax would tend to come off in flakes. Wax somewhat adds to the stiffness as well as the gloss of a finish. Of the other natural waxes used in finishing, few in number, one or two may be mentioned. Japan wax is a curious fatty substance consisting almost entirely of palmitin, derived from the leaves of various species of *Rhus* trees. It has a melting point of about 110° F., and resembles ordinary beeswax in its finishing properties. Chinese wax is the product of a species of *Coccus* insect which lives on the *Rhus succedaneum*. It is very pearly, somewhat crystalline in appearance, melts at 180° F., and consists of the cerolein (cerotate of ceryl). When used in finishing it enables a fine luster to be got.

Spermaceti.—This well known body is the produce of the sperm and bottlenose whales, and is obtained from the fatty portion of the whole body of these animals. This is done by first melting and getting the whole of the oil out, then freezing and pressing, whereby the spermaceti is separated from the sperm oil. Spermaceti is a white, pearly crystalline body, melting at 109° to 120° F.; it consists principally of cetyl palmitate $C_{16}H_{33}C_{16}H_{31}O_2$, with other closely allied substances. It is not used to any great extent, its price being against this. It gives a fine glaze and rather pearly appearance to cloths.

All the wares named above have been almost entirely superseded by the use of the product to be next described.

Paraffin Wax.—This substance is obtained in large quantities from the paraffin shale of Scotland and the petroleum oil of America. It is sold in many qualities, from a soft, faintly yellow to a hard white wax, melting at different temperatures, the various qualities being distinguished commercially by their color and melting point. The usual grades are yellow semi-refined, 108° to 110°; white, 110°, 120°, 125°, 132°, and 140°, the latter being the highest that is made. The higher the melting point the harder and more solid the wax, and the high melting point waxes, when struck, have a metallic ring. A white wax melting at from 120° to 125° will be found to suit well for almost all finishes.

Paraffin wax is not saponifiable, and remains quite unacted upon by alkalies. It does not mix or make an emulsion with water, and on this account it does not form a homogeneous mixing, especially when used in large quantities—it is liable to separate out and float on the top of the mixing box in patches; the cloths, therefore, become irregularly impregnated with it, a most undesirable feature. It is advisable, therefore, to use it as sparingly as possible and to keep the contents of the mixing box well agitated; the use of soap and starch prevents the separation to some extent, but not entirely. It very much assists glazing, giving a fine gloss which is lasting, and not being brittle it leaves the cloths elastic and supple without being greasy. Although there are few objections to the use of paraffin in finishing, it may be mentioned here that it should not be used in sizing, although it is frequently and sometimes unwittingly added. When once in, it cannot be got out of cotton cloths by the ordinary processes of scouring and bleaching. It is therefore left in, and if afterward these cloths have to be dyed or printed, serious defects present themselves. Further, the chlorine of the bleaching process acts upon the paraffin, forming derivative products which, although at first colorless, gradually acquire a yellow tint, which seriously reduces the value of the goods, and, unfortunately, there are no ready means of taking out these stains. This wax differs very much from all the other waxes, not only in its chemical composition, but also in its properties. It is not a simple chemical compound, but a mixture of several compounds having a similar composition and very similar chemical properties, but differing one from the other in their hardness and melting points, and in the proportion of the two elements, carbon and hydrogen, of which they are composed. All these bodies are compounds of the two elements named above, and they are hence called hydrocarbons. They belong to one of the great families of such compounds known as the *paraffins* because at the ordinary temperatures they, and more especially the higher members, are not acted upon by acids and

* This is not in accordance with Fig. 1, which we have been careful to reproduce identically with the original; but we believe that the draughtsman of the latter has made a mistake in the direction of the rotation of the hours, which, if it were accurate, would make it supposed that the dial revolved independently of its support—a very improbable hypothesis.

alkalies. There is a complete series of these paraffin hydrocarbons, varying one from the other in the proportion of carbon and hydrogen they contain and in their physical properties. The lower members are gaseous, the higher members solid, the intermediate ones liquid. The following table gives a complete list of all known:

Paraffin.	Formula.	Boiling Point.	Specific Gravity.
Methane	$C H_4$	Gas	
Ethane	$C_2 H_6$	Gas	
Propane	$C_3 H_8$	Gas	
Butane	$C_4 H_{10}$	0 deg. C	0·600
Pentane	$C_5 H_{12}$	37 "	0·645
Hexane	$C_6 H_{14}$	69 "	0·669
Heptane	$C_7 H_{16}$	92 "	0·699
Octane	$C_8 H_{18}$	116 "	0·730
Nonane	$C_9 H_{20}$	136 "	0·741
Decane	$C_{10} H_{22}$	160 "	0·757
Endecane	$C_{11} H_{24}$	180 "	0·766
Dodecane	$C_{12} H_{26}$	196 "	0·776
Tridecane	$C_{13} H_{28}$	218 "	0·792
Tetidecane	$C_{14} H_{30}$	340 "	0·812
Pentdecane	$C_{15} H_{32}$	256 "	0·830
Hexdecane	$C_{16} H_{34}$	278 "	0·850

Solid Paraffin.	Formula.	Melting Pt.
Ordinary wax	$C_{25} H_{52}$	130 deg. F
Cerylane	$C_{27} H_{56}$	136 "
Myricylane	$C_{30} H_{62}$	143 "

The solid paraffins have not yet been differentiated with exactness one from the other.—*Dyer and Calico Printer.*

TEASELING.

Teasling is one of the most important operations in the finishing of woolen napped goods, because a piece of cloth which has not been well teaseled will not do full justice to the other manipulations of finishing, and to perform the operation properly, it is necessary to have many years of practical experience. The "feel" of the goods and their appearance are all-important guides. If we were to ask an old teaseler, who has acquired an almost unfailing judgment in the roughening of cloth, by what marks and signs he determines whether a piece has been roughened sufficiently or not, he would very likely hesitate with an answer, because, although he may be able to decide to a nicety practically, it would puzzle him to give a suitable explanation of the process, so that those whose experience has not extended over a long course of years might successfully perform the operation. A person with any expert knowledge can, of course, readily determine, in the case of a finished piece of cloth, whether it has been teaseled too much or too little. This, however, is rather difficult during the roughening of the piece in a wet condition. Insufficiently teaseled cloth, when dry, has invariably a more or less raw "feel" when the flat hand is passed downward with the nap. This is caused by the unloosened felt remaining at the bottom.

It is the fundamental principle of correct teaseling to loosen the felt down to the plane of the weave and to lay the nap obtained in this manner, without, however, attacking the thread of the weave itself. The more completely this is done, the finer and smoother will be the surface of the cloth in appearance as well as in feel. With insufficient roughing, the cloth will have a coarse and not clear appearance, and the feel will be more or less rough. The surface of a cloth that has been teaseled too much will look indistinct and cloudy, but or course will be very soft in feel. This clouded appearance was once much liked, and, in order to produce it, the cloth was teaseled to the extreme limit admissible. This custom has been abandoned, however, and an elegant, though smooth and cloudless, face is now desired. As has been said, definite rules for judging a piece of broadcloth cannot be laid down or learned by rote. Still, a few material points, useful for beginners, may be given.

The most important considerations to be taken into account are: 1. Quality and character of the wool. 2. The count of the warp on the loom. 3. The binding of the cloth. 4. The finishing effect desired. 5. The strength of the cloth. The quality and character of the wool are the two most important factors to be regarded in the teaseling process. It is known that a cloth from fine wool withstands a far more violent teaseling than one from an inferior stock, because upon the fineness of the wool depends its felting capacity, and the finer the wool, the more compact the felt. It can be laid down as a general rule that the greater the felting capacity of the wool and the more compact the felt, the sharper the cloth must be treated in the gigging process. Thus, for example, a cloth from good Cape wool—most Cape wools possessing a decided inclination to felt—requires a far sharper teaseling in order to produce a smooth and elegant face than a cloth woven from Buenos Ayres wool. Sydney and Port Philip wools, and, in fact, all Australian wools, require a forcible teaseling. The latter wools often lead the inexperienced finisher astray. The cloth, during the teaseling, has a very soft and open feel, but becomes much firmer and more compact in a dry state, so that when the piece is dried, he will hardly recognize it. A similar behavior is manifested by a cloth consisting in part of noils. On the other hand there are wools which increase in resistance during the teaseling. They increase or "swell," as the expert says. After the first few sets, the cloth begins to grow thicker and firmer instead of softening, and generally demands a forcible teaseling. It is not a rare occurrence to find that a cloth which has been teaseled almost ready in the evening, and has been left lying wet overnight, requires the next morning two, three, or even more sets in order to finish it. This "swelling" is a characteristic of the best and finest wools, and may be accepted as an infallible indication of the excellence of the material.

The count of the warp also demands special attention. The higher the count of the ends, the slighter is the effect the teasels have upon the cloth, and the more it may be teaseled without incurring the danger of loosening or tearing the ends. It is evident, of course, that a cloth with a high count of ends must be teaseled more strongly than one of a low count. The finisher must, therefore, gather exact information concerning the condition of the warp, as this furnishes an important guide for his manipulations, and facilitates his work greatly.

The style of weaving, or the binding of the cloth, has a certain connection with the count of the warp, and must also be kept in view in teaseling. Goods with smooth binding, cloth binding, granite, etc., are not as readily attacked in the process as twilled goods, diagonals, duffels, eiderdowns, etc. Goods having a filling which lies more on the surface, such as filling duffel, tricot, etc., suffer most. It is natural that the filling should suffer more than the warp, and when the finisher has a weave in which the former is unusually exposed, he must exercise great care, for such a cloth generally requires but little teaseling with dull teasels, while goods having a filling which is nearly covered by the warp, such as satin, doeskin, and similar weaves, require a strong and forcible teaseling.

Cloths having a twill which is not prominent, such as castor, eiderdown, duffel, paletot, etc., must be thoroughly roughened in order to receive a delicate and elegant nap, but the operation must not be pushed to extremes, otherwise the twill will become too prominent. The opinion is prevalent that the twill becomes more covered the longer the cloth is teaseled. In fact, the opposite result occurs. The deeper the teasels plow into the weave, the more is its body attacked, and the more prominent becomes the twill. The twill is formed by the thread of the weave, and the more the threads are attacked by the teaseling, the more prominent must the weave formation become. This, however, applies only to goods of a plain surface and short shearing. This is so because, if the roughened nap is not clipped at all, or only half clipped, the twill will naturally remain covered.

Plain cloth, even of a high count of warp, may be teaseled so strongly that, when shorn short, it will show the so-called false twill, which would be a defect.

In considering the desired finishing effect, it is apparent that a cloth which is to have a fairly long nap need not be teaseled as deeply as one which, if possible, is to be steam-lustered several times and then shorn short. Melton-like goods require only little superficial teaseling. On the other hand, satins and kindred cloths are to be teaseled very thoroughly, in view of the subsequent operations, while again military cloths and similar goods, in which attention is paid more to their strength than their elegance, are to be teaseled slightly. The strength of the cloth is one of the most important points to be regarded in the teaseling process, and it is frequently the check that restrains the finisher from giving a piece of cloth a workmanlike, elegant appearance, however much he may desire to do it. It has, of late, become the custom to demand a certain strength in a cloth, both in the warp and filling, but extreme demands in this particular are, it is believed, as yet exceptional. It is admitted that the finisher cannot impart a good appearance to the cloth without teaseling it well, and, of course, deteriorating its strength to a certain extent. To perform this operation successfully, one of two things is necessary. The cloth must either be manufactured from such strong material that, in spite of a sufficient amount of teaseling, it will remain strong enough to comply with all reasonable demands, or its good appearance must be considered as secondary to its strength. A middle course might, it is true, be followed, and the cloth teaseled more and correspondingly longer with dull teasels than with sharper ones. But, even in this case, success, in many instances, is uncertain, leaving out of consideration the greater consumption of time.—*Deutsche Wollen-Gewerbe; Textile Industries.*

PHOTO-ENGRAVING.

Photo-engraving is decidedly the most simple and easiest photographic etching process, and gives, therefore, among all printing processes the most handsome results.

The principle of photo-engraving is the following: Of a negative a reversed diapositive is produced by means of any desirable process, which is printed upon carbon paper, and is then squeegeed upon a polished copper plate in the manner generally used in pigment printing. When the copy is developed a negative pigment picture upon copper is obtained. If the copper plate is now placed in a chloride of iron solution, the latter will have an etching action upon the copper. It will act first on the shadow parts of the negative where the pure copper is exposed, then it will penetrate the thin parts of the pigment negative, which correspond with the half tones of the picture, and finally it will even act upon the dense parts. If the action of the etching is now interrupted at the proper time, that is, before the chloride of iron solution has also penetrated the thickest parts of the negative, which correspond with the light parts of the positive, a positive, deeply etched into the plate, is obtained after removal of the pigment film. The shadows have the deepest etching, less deep are the half tones, while the high lights on which the etching did not act appear as bright copper. The so produced plates can be used for printing like engraved copper plates. For a successful working in photogravure a perfect knowledge of the pigment printing process is necessary, and every one who is well versed in pigment printing will easily learn how to produce gravure plates. The following is an exact description of the process:

1. *Character of the Negatives.*—Most of the photographic printing processes, as, for instance, zinc etching, lichtdruck, etc., require as prime condition for the production of good printing plates a faultless negative. In the zinc etching process, for instance, it is almost impossible to obtain good results from a flat or weak negative.

In the photo-engraving process it is a little different; a well exposed normal negative is, of course, here also to be preferred; it is, however, possible to produce serviceable negatives from weak or hard negatives by proper treatment, to be explained hereafter.

2. *Production of the Diapositives.*—From the negative to be reproduced in gravure a reversed diapositive is first made. This is done by way of the pigment printing process. The paper suitable for this purpose is Braun's diapositive paper, which has the advantage of all other paper that it will adhere to the glass without any previous preparation.

The paper is bathed in the well known manner in a bichromate of potassium solution, then squeegeed—avoiding thereby all air bubbles—upon a glass plate, well cleaned and rubbed with talcum and freed from scratches, etc., and dried. After complete drying the edges of the paper are cut and the same can then be easily stripped from the glass. By drying the paper upon glass the paper will have a highly glossy surface. This has the advantage that during printing it will lie close to the negative, so that faultless and sharp diapositives are obtained. The diapositives may just as well be produced upon bromide of silver gelatine plates in the enlarging and reducing camera. It should be observed here that to produce a reversed diapositive the glass side of the negative should be toward the film side of the bromide of silver gelatine plate upon which the positive is to be made.

The latter method has the advantage of pigment printing, that it permits much quicker work, and at the same time can be connected with an enlargement or a reduction. By suitable development softer diapositives can also be made from the hard and stronger ones from the weak negatives.—*Dr. H. W. Vogel, Anthony's Bulletin.*

THE TEMESCAL TIN MINES.*

By Enoch Knight.

At the present writing, the end of the year 1891, it can be said that the Temescal tin mines, in the hills of that name, that seem to form a detached fragment of the Sierra Madre range, and only eight miles easterly from the Santa Fe station at South Riverside, Cal., have produced the first and only American tin ever sent to the market.

"The San Jacinto Estate, Limited," is the title of the new ownership of the Temescal mines, which for over twenty years after their discovery were tied up in litigation. Colonel E. N. Robinson, through whose efforts most of the developments and improvements have been made, effected a sale of the property to this new English company a year ago last August. By a provision of the transfer it is guaranteed to the former American owners that they may be reinstated in interest again in agreed proportion of ownership by making good certain advances for purchase and development; but the English stockholders are to retain control in any event. It is not undertaken here to state details of the deal, nor is it deemed pertinent to the purpose of this paper. It is a vast property of over 45,000 acres, a considerable portion of which is productive and easily tilled land and has, besides, a valuable water right and showings of gold in one place that will some day be followed up, or rather down. Sir John Stokes, of London, vice-president of the Suez Canal Company, is chairman of the company; Mr. Hugh Stephen, general representative; Mr. E. C. West, engineer; and Captain Stephen Harris, for 40 years a Cornwall mine manager, superintendent of the mining department.

These latter gentlemen have recently been sent out from England and are under instructions to concentrate all their efforts upon the development of the ore-bearing lode already opened, the "Cajalco," in which is being led a third level, and preparations made for the most thorough test of the extent and quality of the ore. There are 30 or more lodes, with substantially the same tracings and croppings as this one, and their long black lines stretch across the crests of the low-lying sandy hills that form the mining camp, as one has seen weather beaten fences show their black outlines above wasting snow banks. These lodes are only a few rods apart and can be marked from one outcropping to another for half a mile, even by the unpracticed eye.

Some 20 buildings, neatly kept and planted about with young trees and flowers, make up the camp; and a pretty sight it is, on a December morning, set off against the distant snow mountains whereon winter has placed her sentinel outposts whose helmets glisten like burnished silver in the quivering sun-lit atmosphere. All work upon the property is stopped except the tin mining and the occasional "feeling" of the other lodes, as opportunity offers, it being, as I have said, the policy of the new company to develop this one source and in the meantime to realize as much as possible for the product, the average British stockholder having become somewhat weary, it is said, in contemplating the nebulous nature of many of his recent American investments. The company is so simplifying that the very restaurant has been let to outside parties, who board the hundred and more men for 25 cents a meal, the company only supplying bunk room.

The fuel used is the lowest grade of soft coal and is hauled 18 miles from Elsinore, the last three miles being over the rude trail that traverses the very pinnacles of the hills, no serious attempt having been yet made to construct easy grades. The coal costs, laid down, $5.25 per ton. Everything else, also, is necessarily taken over this rude mountain roadway. By and by, no doubt, a short branch railway to the Santa Fe station at South Riverside, about seven miles away, will be built.

The writer, on a recent visit to the mines, was allowed to see the confidential reports of the directors of the company, also of the experts, and given the fullest use of all official information. The amount of ore being daily handled, now that things are working well, is something over 30 tons, and the tin metal product about three-fourths of a ton. Captain Harris assured the company, during his visit to England last summer, that he expected soon to be able to make the mine pay expenses; and he says he is now doing it. The product for December was 25 tons marketed (a little being left over from November); the actual amount smelted was slightly more than 20 tons. He estimates the output of this one lode for 1892 at 250 tons, at the present rate

* Abstract of an article in the *Overland Monthly*, February, 1892.

of work and yield of ore. With the third level he expects to get better ore, the present yield being about 4 per cent.

The gross value of a ton of 2,240 pounds of pig tin, at the highest price yet paid, 23 cents, is $515. The superintendent's conservative estimate, however, is $450 a ton; and this year, then, working the ore near the surface and taking into account only this one lode, will, at the lowest estimate, bring to the company, in round numbers, $112,000. Were it not for the high price of labor and the present rude conditions of manufacturing and marketing the product, there would be a handsome profit in working ore that yields even 4 per cent., that being more than double the yield of the Cornwall mines. The prices for labor are as follows, per day: Engineer, carpenter, etc., $5; engineman, $3.25; miners, $2.75; surface laborers, $3.25. The miners that work by contract make about $3. The lowest price paid any man is $2.25, and this leaves him, after paying his day's board, $1.50 a day clear. As to imported labor, there are a few Cornish miners, but they have been years in this country, and even if they were to come from England to-morrow they would demand and receive the local market price of labor.

I wish it were possible to make estimates and predictions as to the future of the Temescal mines more specific and satisfactory, but I have contented myself with presenting all of the obtainable facts and the best opinions of men who, it would seem, are entitled to be believed. My own opinion is that the work now being done, and which is bringing in returns that cover the cost of these twenty or more tons a month, will be doubled before another year, and thereafter increased precisely as fast as the new lodes can be advantageously worked; for there are many things to be attended to all the while, like providing a better and cheaper fuel supply, improving the roads and generally lessening cost and waste.

But there is even now an assured American tin mine. There is no doubt about it. It is very easy to work, the ore cropping out so near the surface of these little low-lying hills over and among which one may drive anywhere in a buggy. It is near a great railway, and in the midst of a rich, cultivated country. I cannot learn that any other deposit of tin ore of equal richness and amount has ever been found that could be so easily developed and handled: and I am very positive that the men who have staked reputation and capital upon this venture feel that they have made no mistake.

[FROM THE INDEPENDENT.]

CONSTANTINOPLE ART TREASURES.

By Prof. ALBERT L. LONG, D.D.

ONE cannot help feeling deeply gratified at seeing the use which is being made of the Porcelain Kiosk (Tchinili Kiosk) in the Old Seraglio grounds in Constantinople. That this building, which was the first structure erected by the conqueror after the capture of the city, should be not only preserved itself as an architectural gem, but should also serve as the conservatory of ancient art, is highly significant. The brazen head of one of the serpents of the twisted column, which once supported the tripod of the priestess of Delphi, and, standing in the Hippodrome, attracted the attention of the victorious monarch on his conquering advance to the great church of St. Sophia, and was shattered by a stroke from his ponderous battle ax, is there in the same room with the Cylinder of Nabonidus and other cuneiform records of Sennacherib's victorious campaign against King Hezekiah, and along with objects from Schliemann's excavations of ancient Troy. In the adjoining apartment is the Jerusalem Stele, a stone from the Temple Court at Jerusalem prohibiting the entrance of a foreigner (that is a Gentile) within the sacred inclosure on pain of death, a stone upon which there can be but little doubt our Lord has frequently looked. Just alongside of this precious object of biblical antiquity is the stone bearing the recently discovered Siloam inscription, with its confirmation of history in regard to the construction of the Siloam aqueduct tunnel. Outside, upon the marble corridor, stands also the colossal Melkart of Gaza, which attracts the attention of the Assyriologist by the striking resemblance which it bears to the legendary Chaldean hero Gizdubar, as he is represented upon the oldest cylinder seals. Thus the collection of objects here preserved establishes the connection from the time of the erection of the building back through the ages to the earliest historic period.

Facing this building and about two hundred feet distant stands the new museum building, with its broad marble steps and massive columns quite in the best modern style of public buildings, with an inscription over the portico in ancient Cufic characters signifying Museum of Antiquities. To an old resident of the city, acquainted with the spirit of the people of the country with regard to what is comprised in ancient art, there is perhaps no structure in the capital which is so suggestive, or which shows so plainly the advance in western ideas made during the present reign. This beautiful new building, almost completed, has been erected mainly by private funds furnished by His Imperial Majesty the present Sultan to the enterprising and accomplished director, Hamdi Bey.

If any one is curious to know the origin of this unexpected zeal manifested by the ruler of this land in regard to objects of antiquity, let him procure his ticket at the modest cost of one shilling, and enter that new building, and he will find that that additional structure contains inestimable treasures which might well excite the envy of the richest museums of the world. The two large rooms upon the ground floor are stocked with the Sidon Sarcophagi, all of which are valuable and interesting, but two of which are so surpassingly beautiful as to richly deserve a special palace to inclose them.

The central object of attraction is the so-called Alexander Sarcophagus. The director, Hamdi Bey, has, I believe, never claimed for it that it is the actual tomb of Alexander the Great, but, inasmuch as it bears the undoubted portrait of Alexander the Great, easily recognizable by every one who has ever held in his hand one of the best coins or medallions of the Macedonian conqueror, this magnificent tomb, worthy of him or any other monarch who ever lived, has received by general popular consent the name of the "Alexander tomb."

It is a rectangular, temple shaped, marble structure, more than three meters high, and covered with an imitation tile roof, ornamented with exquisitely cut volutes, heads of goats and lions, with a Greek border of peculiar pattern and a vine leaf the perfection of elegance and accuracy of detail. Never have I seen the work of elaborate ornamentation carried out with such micrometric fidelity and harmony of idea. The material being of the purest and finest grained marble has admitted of such a fineness and delicacy of finish that the unwary finger passed over them may be cut as with a knife by the sharp marble edge.

The subjects treated in high relief on two sides are a battle scene and a lion hunt. The battle scene is a hand-to-hand combat between Persians and Greeks. The former are distinguished by their dress, their weapons and their physiognomy; the latter are in the classic half clothing which characterizes the figures upon the frieze of the Parthenon.

In looking upon this scene one is immediately led to the conviction that most, if not all, of the Greek faces and some at least of the Persian are portraits. Individuality is stamped upon each one of them. No two are alike. Even the war horses have an individuality. No two are alike, but each one bears that peculiar individual trait of equine physiognomy which enables the true lover of horses to pick out his favorite animal from among hundreds of companions.

At the extreme left is Alexander mounted upon a superb charger. He is represented as faithfully as though photographed from life, with his lion skin helmet and with that peculiar look of his, the look of a prematurely old young man. At the extreme right, but facing toward the center, is an elderly man, probably fifteen years the senior of Alexander, but sitting on his fiery steed with an easy grace which betokens the expert cavalry general. He has a remarkable face, which would attract attention and study in any portrait gallery in the world. Who is he? is the question on every one's lips on looking at him. Can it be Parmenio?

At the center, or half way between these two, is a third personage, who, from his central position, gilded helmet, and the Persian suppliant for mercy kneeling before him, it is thought by some has been intended to represent the one for whom the tomb was designed. His face is younger and of less character than Alexander's. Horsemen and footmen, spearmen and archers, fill up the space. A corpse lies in the foreground with a ghastly spear wound in the side. In looking at the scene one thinks no longer about the marble, or even about the skill of the artist; he thinks only of the scene before him, who they are and what they are doing. Persians and Macedonians somehow become more real to him than they ever were before: he has actually seen them fighting. He has witnessed the battle of Arbela.

In the hunting scene upon the other side the most striking figure probably is that of the noble war horse into whose neck and breast the furious lion has fastened his teeth and claws. The expression of pain and terror shown by the majestic steed as he rears and plunges with the hope of shaking off his enemy is pitiful to behold, while the spear thrust by the royal-looking rider into the heart of the lion is a marvel of dexterous grace and anatomical precision.

It must not be forgotten that this work is *colored*. We have here more colored marble than has been preserved to us in any other monument of antiquity. The genuine "Purple of Tyre" is here in all its various shades, and the effect is truly wonderful. The experiment has here been tried and has succeeded of making the cold marble appear warm with life. Everything here represented is lifelike and real. The beholder gazes upon it in rapt and silent admiration, and turns away too full of the subject to look with much interest at anything else.

Whose tomb can it be? How has it happened that this most beautiful piece of ancient art which has ever been unearthed should bear not a single letter of inscription to indicate the name of the royal owner? How are we to account also for the silence of history concerning this work, which must have cost many months of the labor of the greatest masters of the age? We are struck with the barbarism of the despotic power which would take this costly treasure, along with the three other plain ones of similar workmanship but destitute of figures, and bury them out of sight in a sepulcher twenty meters underground. History records many costly funeral extravagances; but we doubt if any more costly offering to "the infernal gods" was ever made by barbaric prince than was made when this tomb and its companions were let down into that dark and silent Sidon necropolis. It is to that careful sepulture, however, that we owe its wonderful preservation. Let us, therefore, be duly thankful that it was not exposed to the vandalism of tourists; but, at last, after twenty-two centuries, through the skill and perseverance of Hamdi Bey, aided by the patronage of Sultan Hamid, a secure resting place has been provided for it, where art students from all parts of the world may come and study its wondrous beauties.

It is possible that further researches in the necropolis of Sidon may reveal something which may throw light upon the question of the occupant of this tomb. As to its being Alexander's tomb, history seems decidedly against it. Besides, there are other claimants for that honor. Possibly it may have been Perdicca's, the one to whom Alexander when dying gave his signet ring, and who acted as regent after his death. Hamdi Bey, I think, is inclined to that opinion. I have sometimes wondered if it might not be Hephæstion, Alexander's dearest friend, and for whom Alexander made such a magnificent funeral. Some have suggested Seleucus as the one.

We can only say that it seems to have been prepared for some exalted, probably royal, personage. This personage was connected in some way with Alexander and participated in the great battle of Arbela, which is the battle scene so vividly represented. The work has been done by the greatest of masters living at that period. The period could not have been later than 300 B. C. These are conclusions in which we think all will agree who carefully and critically study this wonderful monument.

Second only to the "Alexander tomb" in importance, and by some critical authorities thought even to excel it, is the beautiful marble tomb known as that of "The Weepers."

It has also been colored, but the colors have not been so well preserved as in the other. There is no name or indication of any kind upon it as to its ownership. Eighteen exquisitely cut female figures, six on each side and three on each end, set forth in the most delicate and artistic manner the different phases of feminine grief. They appear to represent the same person—a young matron, as she receives the distressing and astounding news. Her refusal to believe it; her doubt lest it may be indeed too true; her meditation as conviction is being forced upon her; her struggle to realize the sad truth; her beating her breast in an excess of emotion, then bursting into a flood of tears as a relief to her pent-up feelings; and so on through eighteen different stages of grief. All is wrought out with an indescribable delicacy of sentiment and purity of execution. Around the border there is cut in low relief an elaborate funeral procession in work as fine as that of a cameo. M. Perrot, one of the greatest living authorities on art, said, when he saw this monument: "It is worth a voyage from any part of the world to see it."

I have not the space in which to describe the other sarcophagi found along with these two in the necropolis of Sidon. Of all the eighteen only one contains an inscription. It is a massive black diorite anthropoid sarcophagus bearing a very plainly cut and easily read Phenician inscription:

"It is I, Tabnit, priest of Astarte, King of the Sidonians, son of Eshmunazar, priest of Astarte, King of the Sidonians, who am covered up in this coffin. Whoever thou art, O man, who discoverest my coffin, open not my sepulchral chamber and disturb me not, for there is no silver and no treasure here with me. I am alone covered up in this coffin. Open not the sepulchral chamber, for such a deed is hateful in the eyes of Astarte. If thou openest my sepulchral chamber and disturbest me, mayest thou never have any posterity among the living, and mayest thou be deprived of the sun, and of a resting place among the dead."

The fact that this beautiful stone coffin was second hand or stolen from an Egyptian general, as shown by another elaborate hieroglyphic inscription covering the upper part, takes away a considerable part of the sentiment from the pathetic appeal of King Tabnit and affords a good comment upon the annexed imprecatory clause.

As there were two Tabnits and two Eshmunazars who ruled over the Sidonians, it is not quite certain which one this was. The probability is that he was the father of the Eshmunazar whose magnificent tomb in red syenite stone was found near Sidon in 1855 and is now one of the glories of the Louvre in Paris. That beautiful monument bears an inscription, if I remember rightly, of twenty-two lines, and its discovery forms an epoch in Phenician epigraphy. More than forty of the most eminent Semitic scholars have worked upon its translation. The closing part resembles the Tabnit inscription. It reads:

"I am cut off before my time; few have been my days, and I am lying in this coffin and in this tomb in the place which I have built. Oh, then remember this! May no royal race, may no man open my funeral couch, and may they not seek after treasures, for no one has hidden treasures here, nor move the coffin out of my funeral bed, nor disturb me in this funeral bed by putting in it another coffin."

A comparison of the two inscriptions suggests several points of paleographic interest. Through the courtesy of Hamdi Bey I have received a tracing of this Tabnit inscription; and I find, upon placing it over the Eshmunazar inscription, as published in facsimile by the Paleographical Society, that it coincides most remarkably. The forms of the letters l, m, k, sh and others correspond exactly in style, and taken all together, one is almost led to believe that the two inscriptions must have been cut by the same hand.

In the Egyptian ornamentation there is a highly ornate collar or necklace in which appears alternately the "bell and pomegranate, bell and pomegranate," reminding the biblical student of the Levitical sacerdotal robe, and adding not a little to the general archæological interest of the monument.

I am happy to announce that Hamdi Bey's lucky star is still ascending. He has just returned from a tour of exploration and discovery in the district of Smyrna. I understand that he has been so fortunate as to uncover the ruins of a beautiful Greek temple which has been unknown in modern times. It seems to have been overthrown and buried by an earthquake, as shown by the columns all lying in one direction. The size is about one hundred and fifty feet square. The frieze is well preserved, and contains very beautiful reliefs. Hamdi Bey is naturally very much excited over the find. He is contemplating, if the means are forthcoming, the bold plan of bringing the whole structure to the capital and setting it up on the Museum grounds. We earnestly hope that he may continue in the favor of his imperial patron, and find the means of executing this brilliant idea with the same skill and taste displayed in the transportation and installation of the Sidon treasures. In doing so we would add another attraction to a position which is already one of the loveliest in the world.

REMOVAL OF GOLD BY FUNGOID GROWTHS.

PROF. A. LIVERSIDGE, of Sydney, N. S. W., states in a paper read before the Australasian Association for the Advancement of Science, at Melbourne in 1890, that he first observed in 1889 that gold was removed from solution and suspension by fungoid growths, and had since made further investigations. The gold was held in suspension in distilled water, that had been prepared at different times, the gold being reduced from a weak solution of the chloride by means of phosphorus dissolved in ether. A complete precipitation usually takes several years. Examining the bottles which had been settling since 1881, he found that in those having fungoid growths, usually at the bottom of the bottles, the liquid was colorless, but in the others the color was ruby red or purple, the gold being still in suspension. In one bottle put up in November, 1884, having the liquid colorless, a purple

blue fungoid growth had taken place, which under the microscope was a mass of matted purple-blue filaments; but after being dried over a spirit lamp, the filaments retained their form but acquired the luster and color of gold. In 1889, other experiments were tried with more precise results. But it was found that not only moulds produce the result, but also any organic matter living or dead.

A NEW TELESCOPIC PHOTOGRAPHIC LENS.

UNDER the above title, Mr. T. R. Dallmeyer read a paper, the other night, at the Camera Club, London, which aroused great interest and secured a full attendance of members. He commenced his remarks by showing that hitherto only two methods of producing large images had been employed—first, the use of very long focus positive ordinary lenses; and second, the production of a primary image by one positive lens, and placing a secondary magnifier or second positive lens behind the plane of the primary image, which enlarges it more or less, according to its focal length, and its adjustment between the positions of the planes of the primary image and that of the focusing screen, as in the photo-heliograph, etc.

The first of the older methods had been seldom employed except in astronomical photography, on account of its unwieldy dimensions; and the second method referred to is practically useless for ordinary photographic work on account of the great loss of light involved, rendering the length of time necessary for proper exposures so great as to cause it to be almost prohibitive, except in the case of inanimate objects. The new lens is composed of only two elements, and the image given by it is primary and inverted. By the fact of the image being primary and inverted, it looks at first sight anomalous that, for equal extensions of camera, the image given by the new lens is several times larger than that given by an ordinary lens of hitherto known construction. In comparing two lenses, no matter of what form of construction (when focused upon a distant object), if the size of the image given by one is *n* times that given by the other, the focus of the one is *n* times that of the other, provided, as before stated, the images compared are direct, primary, and inverted. The focal length of a lens is measured for practical purposes by the distance between one of the principal planes containing one of the nodal points of the lens toward the principal focal plane and that plane. In most lenses in existence, the principal plane passing through the nodal point referred to can be marked upon the "lens mount," and has already been suggested by Mr. Warnerke as an important addition to the measurement and description of lenses as furnished by opticians. The most recent and important contribution, however, on this subject was furnished by Prof. Silvanus Thompson in a very interesting paper delivered Dec. 25, 1891, at the Society of Arts and published in its *Journal*. In the case of the rapid rectilinear, for example, the nodal point referred to is not exactly at the diaphragm slot, but a little behind it; but in most lens constructions in use the nodal point is within the mounting of the instrument. In some, however, by the accidents of construction, it is slightly behind the lens, as, for example, in certain forms of deep meniscus; and, in others, it is slightly behind the mount or in front, as in Petzval's orthoscopic.

In the *British Journal of Photography* this construction was recently referred to in a letter signed "E. Russell." The object in introducing a negative element in the orthoscopic lens referred to was for the purpose of the cure of distortion, as its name signifies, although it was not perfectly accomplished, and the nodal point is thrown only slightly in front of the lens mount by the accident of construction. Mr. J. Traill Taylor has already pointed out that this form of construction necessitated a slight enlargement of the image; but in his leading article of October 16, 1891, describing the new lens, he says: "We have frequently dwelt upon the advantages that would accrue from such a construction." The argument in Mr. Russell's letter, however, appears to be the chary old one that "there is nothing new under the sun."

Now, the main object of this invention has been to *purposely* throw the nodal point from which the focus is actually measured to any distance chosen in front of the lens itself into space, thus attaining a large direct image without the necessity of a bulky and long extension apparatus.

The anterior element is a positive lens, preferably of large aperture and short focus; the posterior lens is a negative element of some fractional portion of the focal length of the anterior positive lens (in Petzval's orthoscopic it was more than *twice* the focus). Roughly, the shorter the focus of the posterior lens as compared with that of the anterior lens, the greater is the size (for a given extension of camera) of the enlarged primary image produced.

The anterior lens should be preferably of large aperture and short focus; it is self-evident, as in ordinary constructions, the larger the aperture the greater will be the rapidity, and the reason of its being preferably of short focus lies in the fact that the absolute distance between the planes of its own focus for parallel rays, on the one hand, and a near object, on the other, is of course less with a short focus lens than with a lens of long focus.

Referring to the figure, if the negative lens, B, be placed at proper distances from the positive lens, A, the rays can be made to emerge parallel, divergent, or convergent. For the purpose of forming an image for any given position of the focusing screen, they must be made convergent, producing a direct primary inverted image. *It is immaterial what position may be chosen for the plane upon which the image is to be received:* it may be either in close proximity to the posterior lens, or removed to any distance whatever further away, but, in order to focus, it is essential that a correct distance be given between the two elements of the lens itself; in other words, a correct adjustment of their separation, focusing always being most easily and sometimes necessarily accomplished in this manner. For example, supposing the lens were focused upon a very distant object (say the sun), with the focusing screen set at a given distance, it would be impossible, by any adjustment whatever of the focusing screen, to find a plane where the instrument would come to focus for very near objects.

Near objects, with the lenses in their former adjusted or fixed position, would send the rays from such objects, after passing through the entire lens, divergent and not convergent. On the other hand, if the separation were adjusted between the two elements for a near object, and it was then pointed toward a distant object, it would be found equally impossible to find any position for the focusing screen in which the focus could be observed, except, as before stated, by an alteration between the separation of the component elements of the lens itself.

It is evident that the longer the focus of the positive element in the construction, the greater would have to be the separation between the two elements for near or distant planes. In this construction there is, then, no limit to the size of the image that can be obtained, slight adjustment in the separation of the two elements producing the correct focus upon the screen, be it near or distant from the lens itself; but it must be borne in mind that the greater the separation between the plane of the focusing screen and the lens, the less is the rapidity that can be attained.

With regard to the question of rapidity. Supposing the screen be placed at a distance of ten inches from an ordinary lens, and a distant object focused. Say the lens has a focus for parallel rays of twelve inches, if the new lens be made to take its place, and the same object be focused, it will be found the image produced is five times larger with the new lens than with the ordinary one, and, to all intents and purposes, you are practically employing a lens of sixty inches focus. The question naturally asked is, What will be the rapidity? The answer is that you have to consider the front lens placed at a distance of sixty inches from the focusing screen; in other words, the nodal point is thrown forward outside the lens to a distance of sixty inches from the focusing screen.

As in the case of the telescope, the greater the mag-

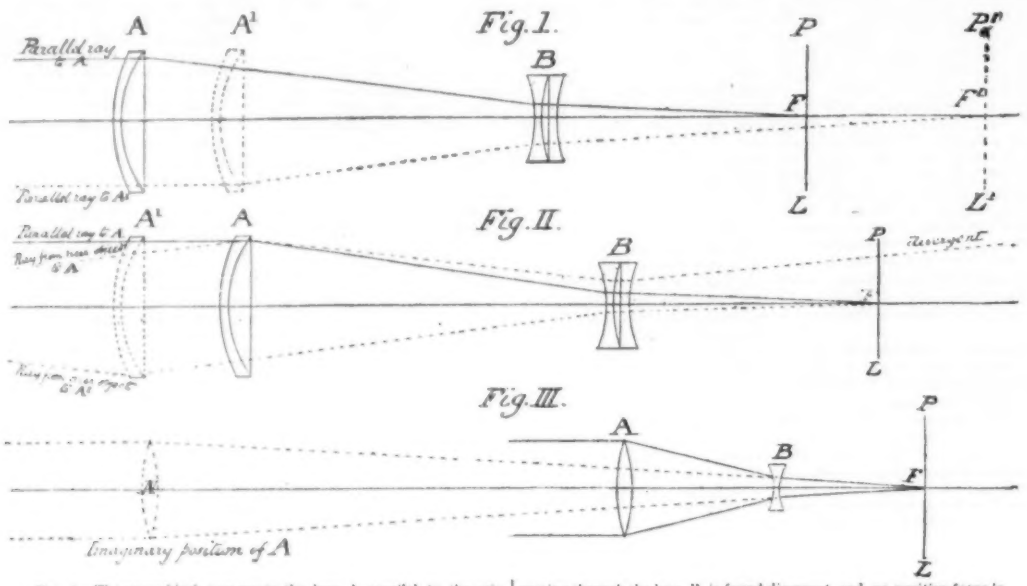


FIG. 1.—The upper black rays meets the lens, A, parallel to the axis, and, by a proper adjustment between A and B, come to focus at F upon the plate PL. If PL be removed farther from the lens, B, to take the position P¹L¹, the lens A will have to be moved slightly nearer to B, and take the position A¹.

FIG. 2.—On the upper side of the axis a parallel ray to A finds its focus as in the dark line on the plate at F. If, however, some ray from a near object falls upon the lens, A, in the direction of the dotted line, after passing through the lens, B, is found divergent, and no positive focus is obtainable.

FIG. 3 represents a beam of rays passing through the two component elements, A and B, coming to focus upon the plate, PL. To estimate the rapidity, it is necessary to consider the full aperture placed at the principal focal plane passing through the nodal point at N. A is thus made to take up an imaginary position. The position of the nodal changes for different positions of the plate, PL.

FIG. 4.—VIEW OF A CHURCH ABOUT HALF A MILE DISTANT, TAKEN WITH THE NEW LENS—EXACT SIZE OF IMAGE ON PLATE.

FIG. 5.—THE SAME OBJECT TAKEN FROM THE SAME POINT WITH A 10×8 R.R. (13 IN. EQUIVALENT FOCUS)—EXACT SIZE OF IMAGE ON PLATE.

nification required, the less becomes the angle included, and there is very little difference with one and the same instrument in *the angle* included for moderate amplification, or great amplification, but, of course, *more of the plate* is covered when it is removed further and further away from the posterior lens.

It will doubtless be interesting to many to know that the applications of this lens to astronomical photography are easily accomplished:

PARTICULARS OF LENS SHOWN—DIAMETER OF FRONT LENS $2^{3}/_{4}$ IN.

Size of plate.	Extension of camera required from flange.	Corresponding foci.	Rapidity at full aperture.
	inches.	inches.	
4¼ by 3¼	6¾	25	F/9
5 by 4	8	30	F/11
6½ by 4¼	10½	37¾	F/13
8¼ by 6½	13	42	F/15
10 by 8	15¼	50	F/18
12 by 10	18	60	F/22
... ...	.. ..	.. ..	
.. ...	56	120	F/40

The negative of the moon was taken with the first rough lens completed, with an extension of only twenty-eight inches. It may be regarded more as an example of possibilities in size and rapidity of action than definition. In connection with this instrument it may be pointed out that the optical finish given to these instruments is necessarily that of the finest polish bestowed upon astronomical work, for the greater the size of image chosen, the more are any slight optical defects exaggerated.

It is possible that the application of short focus concave lenses, such as myoptic spectacle eyes in connection with rapid portrait lenses (that in themselves will form the positive elements), will suggest itself to your minds. Uncorrected lenses in this application will possibly cause disappointment, but Mr. Dallmeyer explained that he was engaged upon the construction of a properly corrected series of negative elements that may be employed in connection with rapid portrait lenses.

In conclusion, the lecturer said that he had endeavored, in this new lens, to reduce the bulk and weight and loss of light to a minimum, and, while thanking his audience for the very kind hearing accorded him, he hoped that they would find the instrument useful.

In addition to the picture of the moon referred to, Mr. Dallmeyer exhibited a number of specimens of work performed by the new lens—sheep and horses at very long ranges; and one that particularly took our attention was the comparison between the sizes of the image produced by a 15 by 12 rapid rectilinear lens and then another taken by the new lens. This, of course, was a severe trial, in that the focus of the 15 by 12 is twenty inches. The image given by the new lens brought the sheep out about five times larger; in other words, as though a lens of one hundred inches focus had been employed. Mr. Dallmeyer referred to the important principle in his new construction as applied to the telescope, in which very great power is obtained within a very short compass.

Before the lecture, two sets of negatives taken from the same point were shown, one of a church distant a quarter of a mile (see Fig. 4), for the purpose of comparing the image produced by a 10 by 8 R.R. lens of thirteen inches focus (see Fig. 5) and the new lens. Other negatives taken with the new lens were also shown, and in all the fine definition was very remarkable.

To practically illustrate the properties of the new lens, two cameras (the one bearing a landscape lens of fifteen inches focus, the other the new lens) were set up a distance of ten feet from a small oil lamp, and, for equal extensions of camera, the image of the flame produced by the new lens was clearly five times greater than that produced by the 10 by 8 R.R.

During the demonstration, lantern slides representing sheep and horses taken from a distance were shown, all representing instantaneous work. A transparency from the negative of the moon was also shown and much admired. In the case of the sheep, comparative negatives taken with a 15 by 12 R.R. at the same distance were shown, the effect of the comparison being very striking.

The foregoing is from the *London Photographic News*.

In the remaining illustrations we present a few photographs taken from our German contemporary "Prometheus," to show the wonderful results obtained by Dr. Adolf Miethe's new camera with a tele-objective.

The objective of this apparatus consists principally of a convex lens of considerable length of focus and a concave lens having short focus. The two lenses are placed a distance apart corresponding to the difference of the two focii. According to optical laws, this arrangement projects an inverted image of an object located a considerable distance from the convex lens. The size of the image varies according to the distance the lenses are held apart, and becomes larger on moving the lenses toward each other; the size of the image also depends on the relative proportions of the focii of the lenses; that is, the greater the difference between the focii, so much larger is the projected picture, the conditions being otherwise the same. For instance, if the relation of the focii is 25 to 1, the projected pictures are about twenty-five times as large as those projected by an ordinary lens, the distance of the object from the camera being the same in both cases.

In order to produce photographic pictures of a high quality by such a system of lenses, the lenses must necessarily have a special form and be rendered achromatic by using crown and flint glass in the usual manner. The entire apparatus looks very much like a Galilean telescope.

By substituting an ordinary opera glass for the objective on the camera, and drawing the bellows out as far as possible, a fairly good picture of a distant object will be produced on the ground glass of the camera.

The pictures shown in the annexed engravings were taken by the same camera placed in Figs. 6 and 7 about two miles from the object, the city of Potsdam, near Berlin. For Fig. 6 an ordinary aplanatic objective of 5¾ inch focus was used, and for Fig. 7, Dr. Miethe's tele-objective above described and with the camera drawn out to 10 inches. The part inclosed by the rectangularly arranged black lines in Fig. 6 corresponds with the detail picture of Fig. 7.

For taking the picture shown in Figs. 8 and 9, the camera was placed about 400 yards from the object, a

FIG. 7.—DETAIL VIEW OF THE PART INCLOSED IN BLACK LINES, FIG. 6.

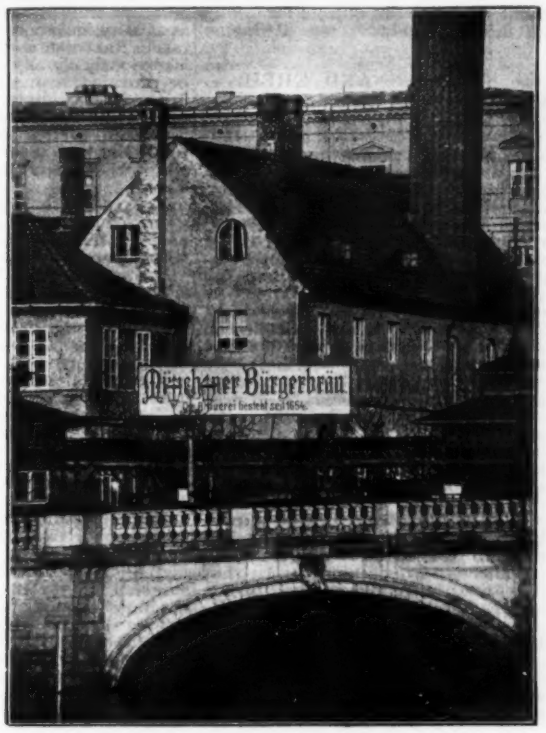


FIG. 9.—DETAIL VIEW OF THE PART INCLOSED IN BLACK LINES, FIG. 8.

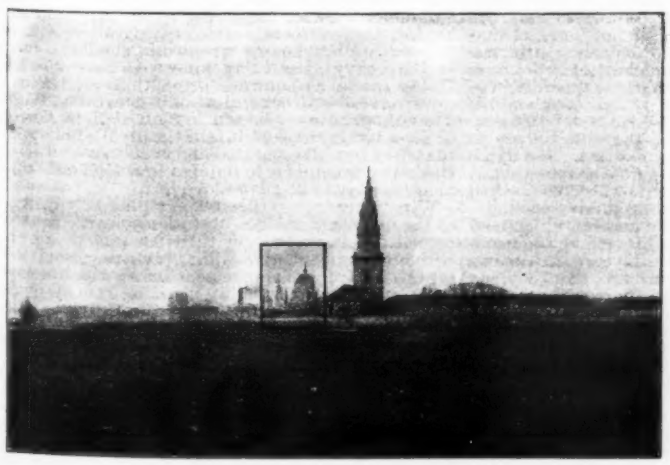


FIG. 6.—VIEW OF POTSDAM, NEAR BERLIN.

FIG. 8.—VIEW OF A RIVER WITH BRIDGE AND BREWERY IN THE BACKGROUND.

river with a bridge and brewery in the background. The picture shown in Fig. 8 was produced with an ordinary objective, and the part inclosed in the black lines forms the subject of the detail picture illustrated in Fig. 9, and was taken with the tele-objective.

By a careful comparison of the pictures of the two sets, it can be readily seen that the contours of the pictures remain the same, and hence the camera could not have been moved nearer to the objects for taking the pictures shown in Figs. 7 and 9. T. G. H.

GENERATING STATIONS AND THEIR PHYSICAL HAZARDS.

By GEO. P. LOW.

ELECTRIC lighting people, in combating the belief that central stations are an extra-hazardous risk, are enduring the penalty imposed for violating the unwritten though well established law condemning cheap and makeshift constructions. We all remember how, only a year or so ago, anything under the sun in the way of a shed would be pressed into service for housing electric light machinery. Everything about the plant wore a temporary aspect: nothing appeared permanent, and the only apparent aim of the electrical concerns at that time appeared to be to furnish electric light at the earliest possible moment. Cheap frame structures of the roughest materials were hurriedly erected, tumble-down saw and grist mills were patched up, and even abandoned barns were made to serve as electric light stations. Then, as if pledged to the motto, "Anything goes," the electrical equipment was placed in reckless disregard of safety, and another electric light station would be launched into existence to tempt fate and invite disaster. The *Chronicle* fire tables show that during the nine years previous to and including 1890, 129 electric light stations were burned in the United States, but considering the wretched construction of so many of them, it is hard to understand why this number is so small unless it be that Providence prevails—not the public enemy. Is it a wonder, then, that the level-headed fire underwriter who does nothing without a reason discriminated against these risks? Their inherent hazards were certainly great and sufficiently so in some cases to prohibit insurance, but now the lesson of experience has been learned, the necessity for central station construction after the most approved methods is fully realized, and the electric lighting industry in this particular, at least, is in a state of transition. New stations are being properly erected and many of the old ones are undergoing reconstruction or are being torn down and rebuilt in accordance with the modern ideas. Better days are already here, and generating stations, whether for isolated or central station work, are no longer necessarily a risk to be avoided as one "sure to go."

I cannot believe that many have a conception of the wonderful influence electric lighting has exerted in developing and more nearly perfecting many mechanical appliances. A dozen years or so ago the ordinary single expansion slide valve engine or the Corliss compound engine represented the highest perfection attained in the art of steam engine building. The value of these engines is not to be detracted from, yet they were all capable of running only at slow speed, and their efficiency was not near so high as the engines manufactured at the present time. Those artificial individuals known as corporations fully understand that the profits of the business they carry on depend almost as much upon the legitimate reduction of operating expenses as upon actual receipts, and in response to their demands the not infrequent use of extravagant countershafting has been made no longer necessary; the automatic high speed engine has been perfected; and finally, the triple expansion engine wrests nearly every ounce of power from steam by bringing it down to almost a vacuum. Even the firing of boilers has become an art, so much so in fact that in some well regulated stations engineers can tell almost the exact amount of coal burned in a given period by noting the "load," or the number of lamps burned during that time. Why this occurs may be easily understood; dynamos and steam engines are both automatic in their action, that is, they develop only such power as is required to perform the work allotted to them. Each arc lamp absorbs electric energy requiring the expenditure of approximately one horse power in its production. If, therefore, fifty arc lamps are burning from a dynamo and ten lamps are switched off, the power required to run the dynamo will instantly drop from say fifty horse power to about forty horse power. The load of ten horse power being taken from the engine, its tendency is to accelerate in speed, but the moment this occurs the governor notes the change and cuts off whatever surplus steam there may be in excess of that necessary to produce the power required. Less steam is, therefore, taken from the boiler, and with proper firing, less coal will be consumed. If, in your travels, you find an electric light station where the exact lamp or ampere load is recorded continuously or at frequent intervals and where every pound of coal going under the boilers is carefully weighed and noted with the time, and results are carefully compared, then, I dare say, you may rest assured that the station managers are live, wideawake, careful men who would permit no careless or hazardous construction to exist that would jeopardize their property. I have never yet had occasion to seriously criticise the electrical equipment of an electric light plant in charge of a man who exercised wise station economy.

Regarding the construction of the station proper, the building, to meet the standard, should be such as is recognized as the best factory construction, and as such it may be of brick or stone, preferably not over two stories high. An electric light station is, in brief, an "electricity factory," and electricity, though intangible, is the product of its whirling machinery, just as fabrics come from cotton and woolen mills, or as sugar comes from a refinery. Each should be of plain mill construction, and, in the standard risk, the roof should be of slate, metal, or gravel. Of course, all precautions should be taken regarding stairways and elevators. If possible, they should be placed outside, or, if inside, they should be inclosed, and provided with self-closing doors and hatches, respectively. The boiler house should be in an adjoining building, and in any instance it is quite essential that the boilers be separated from the engine and dynamo rooms by means of a competent fire wall, carried up through the roof and provided with approved fire doors. It is said that linemen have more to fear from gravity than from the current in the wires they handle, and, if reliable statistics were available, it would probably be proved that more linemen are killed by falling from poles than by electricity. Possibly, too, if the truth were known, it might be proved that defective boilers and flues have caused as many, if not more, central station fires than electricity; but, be this as it may, no one will question the propriety of separating the boiler and dynamo rooms by a fire wall. It is obviously equally important that the station should be provided with a full fire equipment, consisting of fire pumps of ample capacity, good hose on approved reels, fire buckets, tanks on roofs or standpipes and automatic sprinklers judiciously placed. When all these conditions exist, and when everything is kept neat and clean, when oil and waste are properly cared for, when steam pipes are made tight and well felted, when bearings are perfectly aligned, and when litter and dirt are never to be found, then—aside from its electrical equipment—will the station be maintained in accordance with the sound views of the fire underwriter.

But the consideration of the hazards attending the electrical equipment of generating stations is more properly the subject matter of the present paper, and intuitively the first appliance demanding attention is the dynamo. It is not such an easy matter for the layman to recognize the difference between high and low potential dynamos as it was even a few months ago. A new class of low potential machines, known as multipolar dynamos, are being brought forward that appear like high pressure alternating machines in several details, and in some cases alternators are now made to generate low potential currents, which are afterward transformed to high pressures, but from the standpoint of safety it is well to consider all dynamos as high pressure generators. In other words, mount all dynamos properly, keep them all perfectly clean, run all connecting wires after the most approved methods, and then safety will be assured in every instance. Wherever possible, it is advisable to mount dynamos on a stone or concrete foundation for stability's sake, but never place the machine on such a foundation direct. A thoroughly dry wood base, well filled to prevent the absorption of moisture, must intervene. Concrete or stone is a conductor of electricity, and to place a dynamo on such a foundation is possibly to maintain a grounded circuit, the hazards of which have been fully described. As to dynamos themselves comparatively little can be said. They should be kept neat and clean, and they should never be located in places exposed to inflammable dust or the flyings of magnetic material. Machines should always be protected with a waterproof cover when not in use, and they should never, in any instance, be exposed to dampness of any sort. The only parts of a dynamo that are susceptible to wear are the bearings, the commutator and the brushes, and the depreciation on these is low, if the machine is properly cared for. It has been said that "the best system is the man who runs it." Equally true is it that the behavior of a well made dynamo depends upon the care it receives. If the circuits it supplies with current are of faulty construction, the machine receives abuse just as malignant as neglect in cleanliness. Burnouts of dynamo armatures or fields are, therefore, like fuse blowings, symptoms that disorder exists somewhere or other in the system. The destructibility of dynamos by fire is, I judge, about equal to that of high grade steam engines; but, contrary to the prevalent belief, dynamos are not necessarily susceptible to either serious or material injury by water. The dynamo used by the Pacific Oil and Lead Works, prior to their fire last year, remained under oil and water for fourteen days, yet it is now in daily use and giving satisfaction. Another machine fell into the Columbia River while being unloaded from a steamboat, and remained there over three weeks. Yet it was fished out and is none the less efficient for its soaking. About all that is necessary to restore wet dynamos to their original condition is to exercise great care in drying them out by sending a current through their coils. Careless or hurried drying will frequently result in a burned-out machine, which will necessitate rewinding. To do this entails a cost almost impossible to approximate to any close certainty. Some concerns are able to do their own winding, in which event the cost may be 30 or 40 per cent. of that of a new machine, but if it becomes necessary to send the machine to the factory to have it rewound, then the cost, with freights added, may approximate from 50 to 70 per cent., if not more, of that of a new machine. In one or two instances, adjusters have been imposed upon and underwriters have been grossly swindled by misrepresentations regarding the fire or water damage sustained by dynamos, and before settling a loss on a dynamo which is not irreparably injured, it is frequently better to secure the report of a disinterested expert upon its condition. If a dynamo is burned, and yet retains its original shape—that is, if the field magnets or frame have not become cracked or warped or tempered by heat or sudden cooling—then it is safe to say that the only portion which may have sustained serious injury by fire will be the winding, possibly only the few outside layers. Armatures are more susceptible to injury by fire, but they can frequently be rewound and made thoroughly serviceable at a cost varrying from twenty-five to forty per cent. of the original value of the machine. It should be borne in mind, however, that these figures are by no means absolute, as it is quite impossible to establish a universal rule regarding the destructibility of dynamos. Dynamos, or armatures, "burn out" from short circuits, defective construction, or careless or ignorant handling, and these accidents are attributable to conditions which should not exist, and under which the machine is not supposed to run. The rule exempting fire underwriters from losses on dynamos occasioned by fire within themselves is, I think, well taken.

From the dynamo, leads or wires are taken to the switchboard, a very essential contrivance designed to facilitate the throwing of different outside circuits upon different machines, and to group different machines or circuits together in every advantageous manner. The switchboard also contains all such cutouts and switches as are necessary for safety, or to control all circuits and apparatus and also many of the station instruments, such as the lightning arrester, for protecting the apparatus from lightning; the ground detector, for notifying the attendant whenever a ground comes on the circuit, also ammeters for measuring the current strength or amperage of each machine or circuit, and voltmeters for indicating their potentials. Then resistance boxes or rheostats—one for each dynamo—are generally placed on the switchboard. These generally consist of coils of iron or German silver wire so connected to the dynamo that the current used for exciting the field magnets flows through them. By moving the lever of the rheostat, resistance consisting of a wire or wires of low conductivity may be thrown in or cut out of the field windings, entailing a less or greater current flow through the coils and, consequently, a decreased or increased electromotive force from the dynamo, as has been previously explained. Rheostats are essential to the satisfactory working of most forms of dynamos, and in policies the specific amount named on dynamos should include the value of the rheostats, which must be considered not as an accessory device, but as a part of the original machine. The other instruments that appear on the switchboard and have been referred to are not absolutely essential to the working of the dynamo. They are necessaries which enable attendants to keep the plant, both inside and outside the station, in such a condition that both safety and satisfactory service will be assured, and as such their independence from the dynamo will be recognized. A dynamo may burn, yet the switchboard or station instruments may receive no exposure therefrom, neither will a burning switchboard necessarily jeopardize the dynamos connected to it, and for this reason, if for none other, specific amounts should be written on station instruments as well as on dynamos. To "blanket" them is to "blanket" two distinct risks. As to the destructibility of station instruments, those appearing in the switchboard generally consist of five pieces of mechanism comparable to fine clockwork, though not as intricate or as complicated. The instruments found in a well equipped testing room of an electric light station are, however, among the most delicate, exact and expensive used in any branch of science. Their value is frequently great, and being very delicate, they are readily susceptible to injury by either fire or water.

Generally, the hazard attending the use of switchboards is considerably greater than that of dynamos—or, more properly speaking, perhaps, fires originate on or around switchboards more frequently than about dynamos; but in every instance, except, possibly, lightning, electric fires originating in generating stations must be looked upon and deplored as preventable fires. From their nature, switchboards are the points from whence every portion of the system supplied by the station receives its current, and hence the maximum potential and the maximum amperage always exist at that place. It is most essential, then, that the workmanship and materials in and around the switchboard be of the best and most recent character. Unless it is quite impossible to do so, station switchboards should be placed far enough away from walls or partitions to permit easy access on all sides. Do not close in the switchboard in any manner. If it is wainscoted in and provided with a door, some evil genius may file away his cast-off shoes, coat, oily jumpers and waste, broken bottles, and sardine and oyster cans—as I once found—behind there. These are the jackasstical deeds and things that frequently lead to the troubles which occur in generating stations. Permit no part of the switchboard to remain out of sight, and then there is much less liability of litter accumulating. Again, switchboards should be entirely of non-combustible material, such as marble or slate, but wood may be used without material hazard. Of course, all switches, cutouts, rheostats, and other instruments exposed to heating or arcing should be mounted on non-combustible bases. In some low potential systems, and even in electric railway work, bare conductors consisting of heavy copper wires or bars are frequently placed on the front of the switchboard. They are rigidly secured and well separated, and I fail to see that any hazard accompanies their use. Only the best solid rubber insulators should be used behind switchboards, however, and all wiring should be run on porcelain knobs or glass insulators in such a manner as to maintain as great an air space as is possible between the conductors. The use of wood cleats on high potential switchboards is seldom, if ever, advisable, and it would be far better if none but porcelain or glass insulators were used for all work within stations. The wires leading from dynamos to the switchboard should rarely be led down and run under the floor unless the space below be an occupied, finished room, and invariably wires, in passing through walls, floors or woodwork, should be incased in the heavy glass tubes known as floor insulators. Unless special and unusual precautions are taken, it is never advisable to conceal wires in generating stations. They should always be run in plain sight on porcelain or glass insulators, and it is of the greatest importance that they be well separated and rigidly run. To bunch station conductors is to indulge in a foolhardy experiment, always to be advised against.

Wire towers are in themselves a necessary evil so far as the underwriters' idea of station construction is concerned, but in many cases their use may be obviated without inconvenience. It has been suggested that a far less hazardous arrangement than a wire tower, with its shaft or fluelike opening extending from the dynamo room up through the roof, is afforded by embedding a massive wooden girder in a convenient outer wall of the station, then leading all outside wires out through holes bored through the girder. Of course, these holes must slant upward as they pass inward, in order to prevent the ingress of water during rainstorms, and they must be well bushed, preferably with glass floor insulators sufficiently long to pass clear through the timber. When these suggestions have been carried out and the lines have been provided with competent water drips or loops and glass insulators to relieve the wires from strain at the girder, then the hazard attending the use of a wire shaft and tower will have been eliminated. Electrically speaking, no unusual hazard exists in wire shafts and towers, provided the construction is proper, but the objection raised against them is that entertained against all kinds of similar openings, such as light wells or elevator shafts. Should the wiring in them be indifferent or improperly done, however, then a formidable electrical hazard would exist. It will be remembered that nearly all competent insulations are highly inflammable, and in the shaft leading to a wire

tower the wires run vertically, or are hung upon reels. Should a short circuit occur, the arcing would ignite the insulation, which would carry fire along up the line like a taper. Being fanned by the strong draught, which always rises in such openings, the fire would certainly spread, and blazing drops of melting insulation would create unlimited trouble, which would not be averted by throwing the current off the wire or shutting down the plant. In such an instance automatic sprinklers would render a service of inestimable value, but to sprinkle burning wires carrying current would, I think, be making a bad matter decidedly worse.

It is meet that in discussing central station construction mention should be made of outside lines and line building. In low potential systems bare copper is oftentimes used on all outside pole lines, and the practice, though not the best, is generally recognized as reasonably safe provided the circuits are substantially supported and carried above all other wires. Bare wires in overhead electric railway circuits are, however, not to be tolerated except, of course, for the trolley wire, which must be exposed to contact with the trolley. This is necessary principally for the reason that electric railway feeders run under all other lines and are almost sure to cross with falling wires or with circuits under construction or repair. As a preventive the placing of guard wires seems to be the only competent suggestion. Some electric railway companies have placed their supply circuits underground, carrying up feeders to the trolley wires at necessary intervals. Such a practice is to be commended, as in this case at least a wire underground cannot engage in mischief making, for the simple reason that it is not accessible to anything susceptible to injury. Though this condition may apparently prevail in all underground electric constructions, still it does not actually exist, for the undergrounding of electric light circuits has developed new and unlooked for hazards, principal among which is the liberation and ignition of explosive gases. The undergrounding of telephone, telegraph, or other similar signal wires is not, however, subject to the difficulties attending the burying of electric light circuits, and if all such signal wires were placed in subways, the frequent fires that occur from crossed circuits would be obviated.

Regarding the pole lines and outside construction, I have often thought that a first-class system of house top construction would be far safer and far more satisfactory than distributing circuits by pole lines. If all electric light wires were placed on substantial frames, firmly secured to fire walls, and so constructed as to maintain all wires at least ten feet above flat roofs, and if all telegraph and telephone wires were placed on similar structures, entirely separate and apart from the electric light racks, then crossed circuits would occur with less frequency, the streets would be free from poles, and firemen would not be hampered by wires every time they endeavored to raise a ladder to a burning building. Be this as it may, however, I cannot but feel that proper house top construction has a legitimate sphere of usefulness. Line wires carrying high potential currents are generally protected with some weatherproof insulation—that is, an insulation designed to withstand the variations and exposures of the weather. It is also essential that this insulation be very tough and non-abrasive. Some companies run their high potential circuits with a solid rubber insulation, and I believe this to be an excellent practice, despite the yet to be proved claim that the modern rubber insulations fail to survive atmospheric changes.

What has been said will, I hope, convey an idea of the inherent hazards of generating stations, and, in conclusion, I can only emphasize the conviction that, with the competent safeguards and methods of construction now used and practiced, the occurrence of an electrical fire in a generating station is the occurrence of a preventable fire.

THE HOPFNER ELECTROLYTIC DIRECT PROCESS OF COPPER AND SILVER REDUCTION.

AN important innovation has been introduced to the metallurgical world by the well known German scientist, Dr. Hopfner, for the direct reduction of copper and silver from their ores by the aid of electricity. His method, which has been satisfactorily tested, offers, it appears, the great advantage that by its means even the poorest copper ores can be treated with profit. The fundamental principle of Dr. Hopfner's process is the use of chlorides. A solution of protochloride of copper mixed with chloride of calcium or chloride of sodium—which, as is known, possesses an energetic dissolvent effect, not only on the copper ores, but also on the therein-contained silver, lead, and similar combinations, with simultaneous formation of hemichloride of copper—is subjected to the action of the electric current. A circuit process is thereby introduced by which not only is metal electrolytically obtained, but at the same time a lixivium is produced which is capable of lixiviating copper, silver, bismuth, etc., from sulphur ores and which on its return to the precipitation apparatus is again ready to precipitate metal, and at the same time to produce lixiviums.

As the relation of the copper and silver to the chlorine is much greater than to the oxygen, and the copper in the form of chloride or alkali chloride is much more soluble than in the form of sulphate, it is apparently clear that the new process is superior, for example, to the sulphate method of Herren Siemens and Halske, in which ferric oxide sulphate is used as a dissolving agent, but neither silver nor gold can be dissolved, and on account of the poor solubility of the sulphates very large fluid quantities have to be dealt with. Hopfner, in his electrolytic process, uses one or more baths divided by diaphragms into two compartments. One, the anode division, contains electrolytic insoluble carbon anodes; the other, the cathode division, contains copper plate cathodes. A halogen salt hemichloride of copper solution, for example, chloride of calcium, flows by the anodes; a similar solution flows by the cathodes. At the latter, 2·36 grammes of metallic copper are precipitated by the current unit per every ampere hour; therefore, exactly double as much as by the use of an oxide salt solution, for example a copper sulphate solution.

The lye at the cathodes, as it flows past a number of cathodes one after another, is always poor in copper, and afterward is almost copper free. It then leaves the electrolytic bath and is retained for the further application in the already indicated complete circuit process. The anode lye preserves its copper contents, but the copper is finally no longer present as hemichloride of copper, but as protochloride of copper, and in the end it quits the electrolytic bath in a continuous current. This protochloride of copper solution is then used to lixiviate the copper and the silver from pulverized copper and silver ores. Special lixiviating apparatus are used for this process which preserve excellently the higher temperature given to the lye, and provide the most reliable stirring apparatus. The hemichloride of copper lye formed has taken up exactly the same quantity of copper as was previously electrolytically precipitated in metallic copper. In view of the copper contents, however, the concentration of the lye is now twice as great as formerly. In order, therefore, to reproduce the original concentration, the lye which has flowed off from the cathode cells, and which has become copper-free, is again mixed with the lye which came from the anodes and was used for lixiviating the ores. This mixing of the lyes may, of course, also take place at the outflow from the electrolytic bath, so that the original concentration is again produced in the lixiviating apparatus.

The regenerated hemichloride of copper solution flows again to the anodes and cathodes. At the former, the chloride is formed, while the freeing from copper takes place at the cathodes; and the chloride solution is mixed with the copper-freed lye portion, whereupon the mixture travels to the lixiviating apparatus. It is thus seen that a continual circuit process takes place. The fact merits special attention that, simultaneously with the copper, the silver contained in the ores also goes in solution, which is not the case where other extraction liquids are used, for example ferric oxide sulphate. The circuit is only destroyed if small quantities of iron, arsenic, antimony, bismuth, etc., gradually go in solution instead of copper. These extraneous substances should not be precipitated on the cathodes, as the quality of the precipitated copper would thereby be seriously affected. Besides, with a large iron contents the solvent capability of the lye for copper is reduced to about a third or a fourth, as has been shown in practice. This disadvantage is, however, effectively obviated by the red oxide of copper, which, as a very strong base from the hemichloride of copper solution, removes in a purely chemical way such foreign substances, especially iron, from the lye before it is carried to the cathodes. Simultaneously with the iron, the arsenic, antimony, bismuth, and in general all those substances which may defile the copper, can be removed from the lyes in the manner directed. Any silver contained in the lyes resulting from the extraction is separated by itself, either galvanically—it detaches itself then at the first cathode plates of the first bath—or chemically before the copper precipitation. The resultant copper is consequently chemically pure, or it contains, as all electrolytic copper, but insignificant traces of impurities, which do not in the least prejudice its value.

The quantity of copper which can be precipitated in the Hopfner process by a mechanical horse power = 690 volt amperes, with a pole tension of 0·8 volt, and with a sufficient number of baths, amounts to 43·9 kilogrammes (96·58 lb.), the current loss being 10 per cent. Then, as in every ampere hour 2·36 grammes of copper are precipitated, the amount of copper precipitated in a period of twenty-four hours with one volt tension will be

$$\frac{690 \times 2{\cdot}36 \times 24}{1{,}000 \times 0{\cdot}8} = 48{\cdot}8 \text{ kilogrammes } (107{\cdot}36 \text{ lb.})$$

A loss of 10 per cent. deducted, the above calculated quantity of 48·8 − 4·9 = 43·9 kilogrammes (96·58 lb.) per horse power per day is given.

By the use of larger machinery installations, and by reckoning a fourth of the total work necessary on the requisite pumps, and also on the mechanical motion of the lixiviating apparatus, and three-fourths on the electro-dynamic power, it is shown, by taking 30 kilogrammes (66 lb.) of coal per horse power, and 10 per cent. current loss, that almost 33 kilogrammes (72·6 lb.) of chemically pure copper are obtained from pulverized ore, with 30 kilogrammes (66 lb.) of coal. This is a result which has never hitherto been attained; it finds a use for even the very poorest copper ore. It is clear from the foregoing that the Hopfner process, which, among other countries, is already in application in Saxony, Westphalia, and Norway, is technically worked out to the smallest details, and in all probability it will soon establish for itself a high reputation. The new method is of especial importance to those countries in which coal is dear, as, for example, Spain, South Africa, and Chile, the celebrated South American copper-producing country, particularly as the process is also adapted for silver reduction with or without simultaneous copper production.

With respect to the commercial value of the Hopfner process, the following chief advantages which it claims to possess over all similar methods known up to the present may be quoted: (1) Greater efficiency of the electric current, as by the use of hemichloride of copper solutions, with the same current consumption, twice as much copper per hour can be obtained as in the case of sulphate solution electrolysis; whereby the cost of the electric installation is reduced one-half. (2) High solvent capacity, as the halogen salts of the alkali and earth alkali metals possess such a solvent capacity for protochloride of copper and hemichloride of copper that with iron-free solutions concentrations can be worked, which result cannot be obtained with sulphate solutions. (3) General efficiency, as even from the most impure, viz., relatively most worthless, ores an almost chemically pure copper can be obtained, and all other valuable metals present in the ore can also be extracted.

AN INTERESTING ELECTROLYTIC PHENOMENON.

IN a communication recently made to the Academie Royale de Belgique, Prof. Lagrange and M. Paul Hoho describe some experiments made by them on a luminous and calorific phenomenon which takes place under certain conditions when a current is passed through an electrolyte. The phenomenon was first observed in 1844 by Foucault and Fizeau, and has subsequently also been investigated by Righi, Colley, Planté and others. Prof. Lagrange and M. Hoho employed in one experiment a 10 per cent. solution of H_2SO_4, the positive electrode being of copper, with 180 square cm. in the liquid, the negative electrode being a copper wire ¼ mm. in diameter plunged into the electrolyte to a depth of ½ mm. Current was obtained from a battery of accumulators. At first only the ordinary phenomenon of electrolysis is observed; then as the volts are increased, bubbling and boiling occur at the negative electrode, next intermittent arcs take place between wire and liquid, finally a luminous cylinder is formed having the copper wire for axis. The current then becomes steady, and the resistance very high.

On plunging the wire further into the liquid, this series of phenomena can be reproduced. Much the same effects were produced with platinum, zinc, tin, iron, steel and carbon electrodes of different diameters, with sulphuric acid solutions of different strengths, and with a chloride of sodium solution. The production of the luminosity is accompanied by an abnormal resistance which is localized round the negative electrode; with electrodes 29 cm. apart, practically all the fall of potential takes place within 5 mm. of the negative electrode. The shape of the negative electrodes appears to have little influence. Luminous effects can be made to occur also at the positive, but with some difficulty. It is, however, impossible to produce luminosity at both poles at the same time.

KOREA.

AT a recent meeting of the Royal Geographical Society the paper read was on a journey through North Korea to the Ch'ang-pai Shan, by Mr. Charles W. Campbell. Ch'ang-pai Shan, or "Ever White Mountain," is the same as Peik-tu San or White Head Mountain, and the "Long White Mountain," so graphically described by Mr. James in his book of that title. It lies in Manchuria, just beyond the Korean boundary, and is remarkable for the deep blue lake which lies in a deep hollow on the ridge joining two of its peaks. It was not till August, 1889, that Mr. Campbell succeeded in leaving Seoul, the capital of Korea. He journeyed east and north along the coast. The country traversed is typical of the center and north of the country.

"Korea," Mr. Campbell said, "is a land of mountains. Go where you will, a stretch of level road is rare, and a stretch of level plain rarer still. The view from any prominent height is always the same; the eye ranges over an expanse of hill tops, now running in a succession of long billowy lines, now broken up like the wavelets in a choppy sea, often green with forest, but just as often bare, brown, and forbidding. Clear mountain brooks or shallow streams rushing over beds of gravel are never wanting in the valleys below, where a rude log bridge, or curling smoke, or the presence of cultivation, leads you to observe the brown thatch of some huts clustered under the lee of a hill. These hamlets are of two distinct kinds—the purely agricultural, and those which depend as much on the entertainment of travelers as on farming. The site of the agricultural village is a hill slope facing the south. Over this, low, mud-walled, straw-thatched hovels, each standing in its own patch of garden, which is protected by a neat fence of interlaced stems, are scattered at random, and there is not much attempt at a street anywhere. Every house has its thrashing floor of beaten clay, the workshop of the family. The stream which runs past the foot of the hill, or courses down a gully in its side, is lined with women and girls washing clothes with sticks instead of soap, preparing cabbages for pickle, or steeping hemp. Seen from a distance, these places are quite picturesque. The uneven terraces of thatch are brightened by the foliage and flowers of gourds and melons which climb all over the huts. In the gardens surrounding each house are plots of red chilli, rows of castor oil plants, and fruit trees, such as peach, apricot, pear and persimmon.

"The roadside village, on the other hand, is generally a most unlovely spot. The only street is the main highway, which is lined on both sides by a straggling collection of the huts I have mentioned. Heaps of refuse, open drains, malodorous pools, stacks of brushwood for fuel, nude, sun-tanned children disporting themselves, men and women thrashing grain, and occasionally a crowd of disputants, all combine to make it a very indifferent thoroughfare. Most of the houses are inns or eating shops. The main gate of the inn leads directly from the street into a quadrangle bounded on two sides by open sheds, which are provided with troughs for the feeding of pack animals, and on the other two sides by the guest rooms and kitchen. The courtyard is untidy, often dominated by a powerful pig sty, and littered with fodder or earthenware pitchers and vats, whose contents are usually the strong-smelling pickled cabbages and turnips so dear to Korean stomachs.

"The main industry, of course, is agriculture, carried on under disadvantages inseparable from the mountainous character of the country. In Japan and China we know that persevering care and energy have overcome similar disadvantages, but it is not so in Korea. The terrace cultivation, the irrigation works, and above all the patient, almost fastidious labor, which make the hills of Japan and South China yield their share of the earth's good fruits, are practically unknown. Where water is abundant and easily manageable, the lower reaches of the valleys are taken up with rice, the higher portions with millet, beans, buckwheat, etc. A particularly favorable slope, all the better if it faces the south, is usually as much as the sides of the valley are called upon to contribute to cultivation. There is considerable waste about the paths and paddy dikes, weeds are rank and numerous, and the prim neatness so conspicuous in Japanese farming is entirely wanting. Much of the newly broken ground is naturally stony, and little effort is exercised to make it less so. However, considering the small amount of labor expended on agricultural operations, the crops are good, and speak eloquently for the fertility of the soil."

Mr. Campbell reached the river Yalu in October, and although he made every endeavor to reach his goal, the snow was so deep, the passes so overhung with

accumulations of snow, and his guides so terrified, that he was compelled to turn back when within a mile or two of the summit. Nevertheless, he succeeded in making observations of considerable interest.

"Peik-tu San, or Lao-pai Shan (Old White Mountain), as it is at present called by the Chinese of Manchuria, is the most remarkable mountain, naturally and historically, in this part of Asia. The perennial whiteness of its crest, now known to be caused by pumice when not by snow, made the people that beheld it from the plains of Manchuria give it names whose meanings have survived in the Chinese *Ch'ang-pai Shan*, or Ever White Mountain. This designation, obviously assigned to the White Mountain alone, has been extended to the whole range without apparent reason, for no other peak of it, so far as is known, can pretend to perpetual whiteness, whether of pumice or snow. Some 100 miles southeast of Peik-tu San, there is a Ch'ang-peik San (Ever White Mountain) which must approach, if it does not exceed, the White Mountain in height, but the Koreans do not credit it with a snowy covering for more than nine months of the year, and a European traveler who has seen it informs me that it is wooded to the summit, quite unlike Peik-tu San, which is bare of forest for the last 1,000 feet of its height. The great point of interest in the mountain, apart from its whiteness, is the lake—12 miles in circuit according to Mr. James and his party, the only Europeans who have seen it—which lies in the broad top of the mountain at a height of 7,500 feet above sea level, and is supposed to be the source of the three rivers, Yalu, Tumen, and Sungari. The *Tei Tei-ki*, Great Lake, as the Koreans call it, is the nucleus of a mass of legend and fable. It is a sacred spot, the abode of beings supernatural, and not to be profaned by mortal eye with impunity. Curiously enough, neither Chinese nor Koreans have the faintest notion of the real character of Peik-tu San. The Chinese say that the lake is an 'eye of the sea,' and the Koreans tell you that the rock of which the mountain is composed floats in water, for lumps of pumice were common on the Yalu at Hyei-san." Mr. Campbell's crude geological explanations, that this *cho-san* (ancestral mountain) of Korea was a burnt-out volcano, whose crater had been filled with water by springs, were listened to with polite wonder, and treated with much less credulity than they deserved. He pointed to the black dust, to the clinkers, and to the rocks lining the banks of the Yalu for miles, many of which looked as if they had been freshly ejected from some subterranean furnace, but to no purpose. If the occurrences he spoke of had taken place, they must have been handed down by tradition; and it was useless to cite lapse of time—Koreans are ignorant of geological periods—to people whose history extends as far back as 4,000 years ago. According to Mr. Campbell's observation, most of the forest between Po-ch'on and Peik-tu San grows on volcanic matter, which was without doubt ejected from Peik-tu San during successive eruptions. The general inferiority of the timber hereabout to that which he saw elsewhere in Korea led him to examine the soil wherever an uprooted tree or freshly dug deer pit furnished the opportunity. "Beyond a thin coating of leaf mould on the surface, there was seldom anything else but pumice, broken to the size of a very coarse sand. According to the hunters, this was the subsoil everywhere in the forest, and to my knowledge it extends for forty miles at least to the south from Peik-tu San. Nearing the mountain we get the clearest evidence of the character and recency, geologically speaking, of the eruptions which spread this vast quantity of volcanic material over such a wide area. Ten miles due south of the White Mountain, the Yalu, now eight or ten yards broad and very shallow, flows between banks like a railway cutting, sheer, clean, and absolutely devoid of vegetation, for denudation was too rapid to permit the slighest growth." The sections thus exposed were often over 100 feet deep, and at one of the deepest portions Mr. Campbell counted thirteen layers of black volcanic dust, all varying in thickness, and each separated from the layer above by a thin layer of light colored mould. So fine was this dust that the least breath of wind caught it and scattered it freely over the adjoining snow, to which it gave a grimy, sooty appearance.

"The forests of South Manchuria, though uninhabited now, were, we learn from Chinese records, the home of many races in ages past. The comparatively recent kingdom of Ko-ku-rye, which arose in the first century B. C., is said to have occupied the Ch'ang-pai Shan and the headwaters of the Yalu river. Any one who has traveled through the forests might be inclined to doubt such records, for, excepting hunters' lodges, one never notices a vestige of human occupation. But it must be remembered, on the other hand, that the word *kuk* (Chinese *kuo*), country or kingdom, was applied in the early history of Korea and Manchuria to very limited communities, often to mere villages. The word "tribe" better expresses what the so-called kingdoms actually were; and when we bear in mind their low civilization and the impermanent character of their dwellings, it is not surprising that my hasty journey failed to throw any light on the ancient inhabitants of these forests." Since his return, however, Mr. Campbell was informed by Mr. Fulford that Chinese hunters told him of the discovery by them of human implements—of what kind Mr. Campbell cannot say—when digging deer pits near the White Mountain.

Mr. James, in a paper read before the Royal Geographical Society in June, 1887, described very fully the guild of hunters which practically owns and rules the forests to the north and west of Peik-tu San. The Koreans have no such guild, probably because they have not so much to fear from bandits, but each hunter has a recognized right of ownership over a rudely defined district in the neighborhood of his hut. Over this he hunts and traps deer in summer, and sable at the beginning of winter, altogether spending about five months of the year in the forest; the remaining seven are passed at his home on or near the Yalu, either tilling his ground or living in idleness on the proceeds of hunting seasons. Besides sable and deer, tiger, leopard, bear, pig, and ermine are found here; bear, probably the common brown species (*Ursus arctos*), are said by the hunters to be very numerous in summer. In mid-Korea Mr. Campbell has seen a small black bear with a white patch on his chest (*Ursus tibetanus*), but the Yalu trappers did not seem to know it. Hazel grouse were the only game birds he noticed. Throughout the forests insect pests abound in the summer months. Mosquitoes, gnats, and gad flies make the lives of the settlers perfectly burdensome for two or three months of the year, and ponies and bulls quickly succumb to their attacks. The houses are kept constantly filled with birch smoke to drive them off; cattle are protected by fires of greenwood in the open; and men working the clearings carry coils of rope made from dried *Artemisia*, which burns slowly and emits a pungent odor, for the same purpose.

THE FATHER OF MODERN PHYSICS.

JANUARY 8, 1892, was the two hundred and fiftieth anniversary of the death of one of the greatest thinkers of the world, Galileo Galilei. With this event ended a life which had been rich in deeds and successful work, in spite of the enmity which he encountered; and the service which he rendered to science, in which he was one of the earliest workers, will always be gratefully remembered. If we stopped on that anniversary and looked back, it was not simply in deference to the dead, but with admiration of his great and indefatigable mind and with respect for the unbending courage with which he faced the most terrible persecution, speaking openly of what he knew to be true and right.

Galilei was born February 18, 1564, in Pisa, where his father was well known as a mathematician. When seventeen years old he went to the University of Pisa to study medicine and physics, and the latter directed his attention to the natural sciences, which possessed great attractions for him. The teachings of Aristotle, who had lived nearly 2,000 years before, formed the foundation for this branch of science in the time of Galileo, but the young student soon saw that his standpoint was far behind the times. This led him to investigations which resulted in the discovery of very important mathematical and physical laws. The most ordinary events supplied him with subjects for study, and as Sir Isaac Newton was led by the falling of an apple from a tree to the discovery of the laws of gravitation, so the swinging of a hanging lamp in the cathedral of Pisa lead Galileo to the not less important theory of the pendulum, in which he recognized the means of accurately reckoning time. Later he invented the hydrostatic balance—an instrument for determining the specific gravity of bodies—fixed the laws of the center of gravity of bodies, and established the existence of magnetism.

GALILEO GALILEI.

In 1589 Galileo became professor of mathematics in the University of Pisa, and his lectures were received with enthusiasm by the students, but his opposition to the philosophy of Aristotle aroused the ill will of many, who made his position so uncomfortable for him that he accepted a similar chair in Padua. Here he found his proper sphere, and from year to year the number of his intelligent hearers increased. During this period of his life Galileo accomplished his greatest work and made his most important discoveries, such as his study of mechanics and dynamics, the invention of the thermometer, the reconstruction and improvement of the telescope, etc.

The latter made it possible, for the first time, to carry astronomy into scientific channels, giving a firm basis to that which had always before rested on supposition and hypothesis. With the help of the telescope Galileo discovered the mountains of the moon and calculated their height; the satellites of Jupiter; the rings of Saturn; the spots on the sun; the rotation of the sun around its axis; and many other interesting things about the heavenly bodies, and of great importance as beginnings of the study which convinced him of the truth of the Copernican theory, according to which the earth has a double movement, while the sun is the central body of our system of planets.

After teaching eighteen years in Padua, Galileo was called as mathematician and philosopher to the court of the Grand Duke at Florence, where he was able to devote himself entirely to study. Here also his labors were rewarded by a number of important discoveries in the realm of astronomy and physics; but he again found himself exposed to the attacks of his enemies, the number of whom was increased by jealousy of his fame. In spite of this, however, he declared openly and without reserve his belief in the theory of Copernicus. This did not meet with the approbation of the powers of the church, who considered the theory heretical and contrary to the text of the Bible. The Inquisition possessed a power which was almost unbounded in questions of belief, and this power was defied only at the risk of death at the stake. But the brave champion of his convictions was not intimidated; in a letter to the Jesuit Castelli, he explained that in questions of natural philosophy, not the Bible, but science should decide, and that this was not the province of priests, but of scientists.

This bold letter did not go unnoticed. It reached the Inquisition at Rome in 1615, and an investigation was immediately begun. Whether the dreaded judges in clerical garb were restrained by the already celebrated name of the great investigator or by the intercession of his friend Cardinal Barberini—who was afterward Pope Urban VIII.—is not known, but no sentence was declared against Galileo, although the teachings of Copernicus were condemned as heretical. Galileo escaped, for a time, the grasp of the "holy" Inquisition, but his sharp answers to the charge drew upon him the enmity of the Jesuits.

His friend Barberini was made Pope in 1623, and he went to Rome to secure the removal of the sentence condemning the writings of Copernicus, but Pope Urban VIII. would not run the risk of setting aside the decision of the Holy College for fear of being suspected of heresy, and, therefore, Galileo's efforts were unsuccessful.

Now he carried out his long cherished plan of setting forth his opinions in regard to the theory of his great predecessor, which he wrote in the form of a dialogue between the adherents of the old and new schools, the result of the discussion being, of course, the triumph of the new theory over the old.

Scarcely had Galileo's book appeared when it was seized by the Inquisition, and an inquiry against the author begun. He was summoned to appear before the judges and defend himself, but, knowing that he could not count on their leniency this time, he tried to escape the journey to Rome, but in vain. In 1633 the gray-haired old man of sixty-nine appeared before the Holy Office to answer the charge which the zealots had brought against him, the principal ground of complaint being his disobedience of the command of 1616 to renounce the theory of Copernicus. In answering the charges he limited himself to the statement that he had no desire to place himself in opposition either to the text of the Bible or to the statutes of the church, and did not consider that his science was at variance with them.

In order to save his life, which would otherwise have been sacrificed at the stake, he had to deny, on his knees, the truth of the opinions he had expressed and the theory that the earth moved. When the oath had been administered and he saw the judges nod to each other with a malicious air, all the pride of the savant impressed by the truth of his knowledge was roused in the old man, and he spoke, in a tone of deepest conviction, the celebrated words, "It does move for all that!"

For the rest of his life Galileo was a prisoner of the Inquisition, although they did not throw him into jail, like a criminal. He was allowed to live at Arcetri, near Florence, with the strictest instructions not to leave the parish. All his movements were watched and reported to the Inquisition. He passed nearly nine years here, in a sort of banishment, living exclusively for his work, until the indefatigable worker was at last overcome by the burden of years. Bodily pain embittered the last years of his life, and he finally become totally blind. He died January 8, 1642, mourned by his friends, who, although very numerous, could not save him from the persecutions of the Inquisition.

Galileo Galilei is the father of modern mathematics and physics, and the principles and laws laid down by him form the foundation of these important branches of science. As he searched the starry heavens, opening new paths to the eye, and raised the veil from the secrets of nature, he paved the way to the greatest heights of science, which it was the aim of his life to reach.—*Illustrirte Zeitung.*

ITALIAN EXPERIENCE WITH THE PASTEUR METHOD FOR HYDROPHOBIA.

WE have before us the committee's report of the working of this institution—"Instituto Antirabico Milanese," as it is officially called—for the two years that have elapsed since its foundation, and a most interesting document it is. Financially, the Institute is in a flourishing condition, thanks mainly to the liberality of local business houses, seconded by careful management. Therapeutically, it has more than justified its establishment. Dr. Remo Segré, its director, having passed in review the various methods of combating the canine virus in the human subject, decides most emphatically in favor of that of Pasteur. His statistics, checked in every possible way, certainly bear out his decision—the one modification he ventures to make on the method of his master being as to the dose of the matter inoculated. This he would certainly increase, even in the case of children. Dr. Segré uses a syringe of two grammes and a half, and employs an entire centimeter of marrow for each patient. He obtains an emulsion much denser, and therefore richer in the remedial principle. "It is notorious," he adds, "that children form the larger contingent of our patients and have a greater receptivity for the canine virus than adults. A more energetic action of the remedy being therefore required, he gives the child as large a dose as the grown man. On the system of the parent institute at Paris, he divides the patients under treatment into four categories. The first, in his report, includes 108 persons bitten by hydrophobic animals whose rabies was confirmed by experiment in the laboratory, or bitten by animals whose bite was followed by death from hydrophobia in other persons. In this category, out of 108, there were but two deaths. The second category comprises 121 cases of persons bitten by animals whose rabies was tested and reported by a medical man or a veterinary surgeon. In this again, out of the 121, the deaths were only two. The third category contains nine doubtful cases. In this no death occurred. The fourth and last category is made up of cases "remanded"—that is, of persons bitten by dogs or animals, but in whose cases the evidence of being bitten was not sufficiently complete to justify their being subjected to the Pasteur treatment. This, of course, includes no deaths in Dr. Segré's report. He claims a lower percentage of mortality than can be shown by

any other Pasteur Institute on the Continent, and some of his remarks are of interest as evincing the care he bestows on the subjects brought under treatment. Having shown that male cases are more numerous than female, and that children are more often bitten than adults, he observes that the more the bites on a patient and the more various the parts bitten, the more probability is there that the animal is hydrophobic. With regard to the four deaths that occurred after treatment, he says that cauterization had been practiced on all, and without loss of time; with the actual cautery, moreover, which is considered the best in such lesions. This fact of the greater mortality occurring among the cauterized is in absolute keeping with the statistics of the Pasteur Institute at Paris. Dr. Segré adds that a prompt cauterization, made within half an hour after the bite, has always a certain value, but it must be a liberal cauterization, deep and, above all, immediate; otherwise it is useless or worse. He concludes by saying that the Pasteur method is not absolute. It does not save all hydrophobic patients, just as quinine does not cure all malarias, or salicylate of soda all rheumatisms, or mercury all cases of syphilis; while each of these remedies has a specific action which no one doubts. In like manner the Pasteur method, though not invariably successful, has the incontestable merit of having greatly lowered the mortality from hydrophobia, and may yet be so far perfected as to reduce the victims to the fell malady to an almost inappreciable minimum.—*The Lancet.*

THE MANAGEMENT AND CARE OF PATIENTS WITH HEMIPLEGIA RESULTING FROM CEREBRAL HEMORRHAGE.*

By WILLIAM M. LESZYNSKY, M.D., Lecturer on Mental and Nervous Diseases at the New York Post-Graduate Medical School, etc.

IN discussing this subject, we must accept the term "hemiplegia" (paralysis of one side of the body) as indicating the predominant clinical manifestation of a disease, and not descriptive of the pathological process itself. In other words, to speak of hemiplegia as a disease would be at variance with our knowledge of its pathology and in opposition to the modern principles of nomenclature. In the vast majority of instances it is symptomatic of the rupture of an intracranial blood vessel. This condition, which occurs suddenly and places the individual *hors de combat*, is essentially due to disease of the arterial system. It is merely supererogatory for me to mention that hemiplegia may result from other causes, such as cerebral embolism or thrombosis, or meningeal hemorrhage, or from a tumor involving the intracranial portion of the motor tract, or from a unilateral lesion in the upper cervical portion of the spinal cord. I shall therefore confine my remarks to hemiplegia in the adult as a result of cerebral hemorrhage.

The hemorrhage is far more apt to occur in or near one of the corpora striata than in any other part of the brain. The point of selection is most frequently one of the lenticulo-striate arteries which has developed miliary aneurisms. All trustworthy observers are agreed that morbid changes in the arterial walls precede their rupture, although there are differences of opinion as to the character of such changes.

The extremities which are affected are always those on the side opposite to the lesion in the brain. This depends on the anatomical fact, so well known to you all, that the motor columns decussate in the anterior pyramids of the medulla. Thus, any unilateral affection of the nervous centers situated above the decussation of the pyramids, if it causes paralysis at all, invariably causes paralysis of the opposite side. Those movements which are performed in harmony by the two sides of the face or body remain unimpaired in hemiplegia.

Hemiplegia from a lesion of one side of the brain is not necessarily so complete as to present a maximum loss of power. Not infrequently the face escapes entirely.

Sometimes the leg can be moved perfectly, while the arm is completely paralyzed. Power is usually regained in the leg earlier than in the arm. A comprehensive and practical knowledge of general medicine is a *sine qua non* in the management of these cases. Its rational treatment presupposes a familiarity with its pathology. Obviously it is beyond the scope of this paper to enter at length into a technical and exhaustive description of cerebral hemorrhage in its various phases.

Cerebral hemorrhage is relatively frequent after the fortieth year and becomes more common as age advances. The belief that it is of more common occurrence in men with short, thick necks and florid faces than in those who are of a different build is a popular fallacy. There is no such thing as an apoplectic constitution. Some families exhibit a predisposition to cerebral hemorrhage. Hence it has been assumed that the disease is hereditary. It is only an indirect result of the inherited tendency to arterial degeneration.

Most writers speak of prodromic symptoms, and mention the following as premonitory signs of cerebral hemorrhage. Headache, vertigo, tinnitus, or numbness in the hand or foot; facial paresis, coming on suddenly without spasm, and usually disappearing within a few hours or a few days. There may be loss of speech with this facial paresis, but more often defect of speech only. All of these symptoms are likely to arise where arterial degeneration exists, and may be due to local circulatory disturbances resulting either from gradual narrowing of the lumen of the vessel, or from thrombosis or embolism—or possibly from minute hemorrhages; thus producing on the one hand a transient circumscribed anæmia and on the other cerebral softening.

They may appear separately or variously combined, and although all of them may occur without being followed by an apoplectic attack, yet in the old and middle aged, especially when the arteries are degenerated, they should be regarded as warnings. The rupture has been known to occur without any precursory symptoms whatsoever.

Among the exciting causes of the attack may be mentioned excessive emotions, cold baths, and indulgence in stimulants, provided that the vessels are in the diseased condition which seems to be a necessary antecedent of hemorrhage; temporary obstruction to the return of venous blood from the brain, in such actions as coughing, sneezing, laughing, or straining at stool. It has been claimed that its direct effect must be small.

A number of instances have occurred under my observation, and no doubt many of you have seen similar cases, where the patient has been found in the closet, either paralyzed or dead from cerebral hemorrhage, undoubtedly as a result of straining at stool.

Cerebral hemorrhage sometimes occurs first while the individual is making some violent effort or subjecting his vascular system to an excess of pressure. Sudden exposure to cold may increase the arterial tension by inducing extensive contraction of the cutaneous vessels. Cerebral hemorrhage has also been known to occur during sleep, when the pressure in the cerebral vessels is supposed to be particularly low. I have often thought that possibly a change in the pressure might have been occasioned by an exciting dream.

Hemiplegia may occur suddenly without loss of consciousness. Then the recognition of the paralysis is simple both for the patient and the physician. During coma the diagnosis is frequently attended with difficulty, owing to the general and complete muscular relaxation. The stertorous breathing and the concomitant facial paralysis are quite characteristic. In case the coma is only partial and the muscular resistance is feeble or lost upon one side, the diagnosis is clear.

While the patient remains unconscious the prognosis is doubtful, as we are unable to determine the extent of the hemorrhage. He may die comatose from shock, asthenia, or some complication.

Should consciousness be restored and the vital signs be maintained, the prognosis as to recovery from the paralysis depends upon a number of factors. Recovery from hemiplegia will occur from any kind of lesion, if it be a small one. If the patient begins to move the arm next day, he is likely to get well altogether. We cannot infer so much from early recovery of the leg, as this is very often not completely paralyzed at the outset, and we know that it frequently recovers when the arm remains much paralyzed. When rigidity of the limbs takes place, no further improvement will follow. In this connection it will be of interest to call attention to some of the clinical signs of hemiplegia which heretofore have not been observed nor their value recognized.* Corresponding to the well known fact that in the facial paralysis accompanying hemiplegia the orbital portion of the nerve is usually unaffected, a similar phenomenon may be observed in the upper extremity in the fibers of the spinal accessory nerve. This nerve divides into two branches—one supplying the sterno-cleido-mastoid muscle and the other the trapezius. As a rule, the branch to the sterno-cleido-mastoid escapes, while that supplying the trapezius is paralyzed. The latter paralysis manifests itself in the drooping of the shoulder while at rest. The paralysis in the lower extremity, which is usually neither complete nor permanent, also shows several characteristic peculiarities, which explains the fact that walking is still possible even in severe cases.

In such patients, while in the supine position, one can demonstrate that active elevation of the extended leg to a certain height can still be accomplished, although feebly. The dorsal flexion of the ankle joint is nearly or completely abolished, but plantar flexion can be performed with considerable force. In the prone position the flexors of the knee joint are nearly or completely paralyzed, while the extensors show a well marked or almost normal strength. *Therefore in hemiplegia the muscles which are especially important in locomotion are the ones that are the least affected.*

During the early stage the clothing should be carefully removed, and all jarring of the head or body should be avoided. A ligature about the extremities close to the trunk will prove serviceable in diminishing the volume of blood in the internal organs, thus relieving the intravascular pressure and hastening the formation of the clot. This procedure is most likely to prove efficacious where the symptoms are indicative of a large hemorrhage, or in those cases where there is an apparent tendency to an extension of the hemorrhage.

Absolute rest in bed should be enjoined, no matter whether the attack be very mild or severe in character.

In case unconsciousness is present and lasts more than a few hours, the bladder should be relieved by the catheter. If there is reason to believe that there is an accumulation of fæces, five or ten grains of calomel or two drops of croton oil should be placed on the tongue, or an enema may be given. Whenever there is serious difficulty in swallowing, the administration of food by the mouth should be forbidden, on account of the danger of its entrance into the larynx. A day or two without much nourishment will do very little harm. If it is thought desirable, rectal alimentation may be resorted to. Further details in the management of this stage will suggest themselves according to indications.

There is neither clinical nor experimental evidence to prove that we possess any drugs whose administration will hasten the absorption of the extravasated blood or relieve the patient of his paralysis. As we cannot remove the clot or directly hasten its absorption, let us ascertain what we can do for our patient. Before he is able to leave the bed much can be done by careful management and close attention to details to prevent unnecessary complications.

A good nurse or an intelligent attendant will prove quite an acquisition. Bed sores over the sacrum and over the heels are not essential features of the malady, but are usually the result of carelessness and neglect.

The position of the patient must be frequently changed, and either by a water bed or by various mechanical devices the points that are subjected to pressure must be protected.

In addition to these measures, it has been my custom to use a mixture containing two drachms of the oxide of zinc to the ounce of alcohol. The skin that shows any redness is painted daily with this preparation. As the alcohol evaporates, a thin coating of zinc remains on the surface. In rare cases the formation over the buttocks of a so-called bed sore, which is due to trophic changes, may occur, despite the most careful vigilance. A few days after the attack, all joints of the paralyzed limbs should be daily subjected to gentle passive motion, in order to prevent the development of ankylosis. This is more likely to occur in the shoulder joint, and may also be classified among the avoidable complications. Electricity, in the form of the induced current, should not be used until from four to six weeks after the onset of the attack. The strength of the current applied to the paralyzed limbs should be just sufficient to produce slight but evident muscular contractions. The applications are to be made every alternate day, the entire *seance* lasting from ten to fifteen minutes. Faradization keeps up the nutrition of the paralyzed muscles and improves the condition of the peripheral circulation. The same may, however, be accomplished by suitable massage.

In view of the clinical fact that the extensors in the upper extremity and the flexors in the lower extremity are the muscles usually paralyzed, our electrical or manual manipulation should be directed in greater part to these groups of muscles. These applications will be of service while we are waiting for compensatory restitution of function. They prove useful as an artificial exercise.

In the presence of contracture, which generally develops later, much can occasionally be accomplished by the use of galvanism applied to the brain and the peripheral nerves. The *anode* is placed over the parietal eminence on the same side as the lesion, and the *cathode* over the trunks of the nerves which supply the rigid muscles. The current is gradually increased by the use of a rheostat, until the patient receives from three to six milliamperes, the *seance* lasting from three to five minutes. Any sudden interruption in the circuit, either by removal of electrodes or by rapid increase or diminution of the current strength, should be carefully avoided, or sudden vertigo and other unpleasant symptoms may supervene. We must constantly bear in mind that central nerve fibers that have been torn across or broken up in any part of their course do not undergo regeneration, and that motility cannot be restored in those parts which receive no motor impulses. We must not, therefore, delude ourselves in the belief that we can *cure* a hemiplegia. The most potent remedy that we possess is a combination of the "essence of patience" and the "tincture of time."

A partial restoration of function will take place in spite of all methods of medication instituted with the object of *curing* the paralysis. Here is where the *vis medicatrix naturæ* comes to our aid. Hence our efforts must be concentrated with a view to the prevention of another attack. This constitutes the most important element in the rational management of these cases. Nature cannot be trusted in this instance.

It may be asked, Upon what grounds are we enabled to infer a predisposition to cerebral hemorrhage?

1. From the history of a previous attack.
2. From the constitutional state which induces arterial degeneration—*i. 'e.*, senility, chronic nephritis, rheumatism, gout, syphilis, lead poisoning, etc., often accompanied by cardiac hypertrophy.
3. From the presence of arterial degeneration itself, as manifested in the radial and temporal arteries by their rigidity and tortuosity. These evidences of degeneration are extremely suggestive, but are not proof positive of a similar condition of the cerebral blood vessels. As a matter of fact, a number of cases are on record where post-mortem examination and careful microscopical investigation have shown normal celebral vessels coexisting with degenerated temporal and radial arteries. On the other hand, the presence of retinal hemorrhages furnishes an indication of considerable value. They are significant, inasmuch as they point to a state in which cerebral hemorrhage is likely to occur. Some recent writer has referred to a varicose condition of the sublingual vessels as being one of the signs of arterial degeneration that is highly suggestive of a similar state in the brain. I have been unable to confirm this statement.
4. From the presence of high arterial tension, as determined by the radial pulse.

These are questions which demand immediate investigation. In all cases of cerebral hemorrhage the condition of the arteries (statical, as atheroma; dynamical, as degrees of tension) is a matter of first importance. Too much stress cannot be laid upon this point. We should never fail to examine the urine and satisfy ourselves as to the integrity of the heart and kidneys. In fact, every organ in the body should be examined.

Granting that the cause of the arterial degeneration is to a great extent irremediable, let us devote our attention to the avoidance of exciting causes of the rupture. Every patient should be repeatedly impressed with the possible danger to which he exposes himself while straining at stool. He must be taught to avoid all additional causes that have been previously enumerated. Sneezing or coughing should be controlled or modified. Anything that is likely to produce a sudden increase of arterial tension should be scrupulously avoided.

In conjunction with the foregoing, the general plan of treatment which will be found appropriate in most cases would be to regulate the diet to suit the individual case; to reduce the quantity of nitrogenized food (if it had been used in excess); to keep the bowels free; to diminish high arterial tension by the use of salines or mercurials, or nitroglycerine, the nitrites, etc.; to administer antisyphilitic remedies when necessary. There is no proof that the use of strychnine, hypophosphites, or other so-called "nerve remedies," directly influences the paralysis. They should be restricted to those cases in which they are indicated for improving the general health.

I have thus briefly outlined what seems to me to be the proper method to be adopted in the management of an unfortunate class of cases that taxes the resources of the physician to the utmost.

Much of our success in averting another attack will depend upon the co-operation, self-denial and self-control of our patient.—*N. Y. Med. Jour.*

* Read before the Practitioners' Club of Newark, New Jersey, January 4, 1892.

* Wernicke. *Berlin. klin. Wochenschrift*, 1889, No. 45.

A HEATED bearing will throw ropes out of the grooves or cause belts to leave the pulleys, sometimes leading to an extensive breakdown.

VALUATION OF ALUMINUM AND ITS ALLOYS.*

By Herr F. REGELSBERGER.

THE author gives the following as his complete method of determining the silicon: 4 grammes of clippings are weighed into a deep porcelain dish, covered with a clock glass; 80 cubic centimeters of aqua regia (30 cubic centimeters of nitric acid of specific gravity 1·35 to 70 cubic centimeters of hydrochloric acid of specific gravity 1·16) are gradually added with care, and the whole is warmed. Then with continued boiling about 30 cubic centimeters of strong sulphuric acid are added. When acid vapors cease to be evolved, 150–200 cubic centimeters of water are carefully added, the clock glass still being kept on, and finally the precipitate is filtered and well washed. The precipitate is ignited in a platinum crucible direct and weighed. Evaporation with pure hydrofluoric acid is now performed, loss being taken as SiO_2. If now the residue is not of a pure red, it is warmed with a mixture of hydrofluoric acid and a little concentrated nitric acid, and then once more ignited and weighed; the difference between the weight now and the previous weighing is due to silicon. The introduction of sulphuric acid in the foregoing operation is necessary in order to get a precipitate which is sufficiently well matted to filter well.

VALUATION OF FERRO-ALUMINUM.

Estimation of the Aluminum.—Five grammes of the material are dissolved in dilute sulphuric acid in a porcelain dish covered with clock glass and heated on asbestos until acid vapors are evolved; water is then added. Should it be desired to determine the silicon, the solution is made up to 300 cubic centimeters and filtered into a dry flask; 100 cubic centimeters of this are reduced with bisulphite or with iron wire, and nearly neutralized with sodium carbonate solution and then poured into a boiling mixture of 50 cubic centimeters of pure caustic potash solution (= 10 grammes of caustic potash) and 40 cubic centimeters of pure cyanide of potassium (= 8 grammes of potassium cyanide). If iron has been used for reduction, more cyanide is required. Here it is to be noted that a small quantity of iron and manganese (if present) are precipitated. The solution is made up to 500 cubic centimeters and filtered. To 300 cubic centimeters (equivalent to 1 gramme of the original material) a concentrated solution of ammonium nitrate is carefully added, after which the whole is boiled for about half an hour until the alkalinity has almost disappeared. A drop of ammonium hydrate is now added, and the precipitate is filtered off and washed until the washings show no further blue with ferric chloride.

The precipitate is ignited in a platinum crucible and weighed as Al_2O_3. Should the precipitate be slightly greenish, then iron is present, due to decomposition of the potassium ferro-cyanide by continued boiling of the ammoniacal solution. In this case the finely-powdered aluminum oxide is again ignited and then treated in a covered beaker with concentrated hydrochloric acid and titrated, without filtering, with stannous chloride. In the brown precipitate obtained above on boiling with caustic potash and potassium cyanide, the manganese may be determined by igniting and weighing and then titrating the iron (the amount of manganese thus being got by difference).

For the Estimation of the Iron.—In ferro-aluminum the sulphuric acid solution may be reduced with zinc and titrated with permanganate (or the solution used for the aluminum determination may also be taken).

Estimation of Manganese.—This may be performed in a separate solution according to the method of Volhard or of Hampe, or it may be estimated as already indicated under (*a*).

Estimation of Silicon.—The first residue obtained under (*a*) consists of a mixture of silicon, silica, and ferric oxide. This may be purified while still moist by boiling with caustic potash.

Estimation of Carbon.—This is carried out by oxidizing 5 to 10 grammes of the material with chromic and sulphuric acids, and weighing the carbon dioxide formed.

Estimation of Sulphur.—In the usual way after solution in aqua regia.

Estimation of Phosphorus, Titanium, etc.—These are performed as in the case of pig iron.

Approximate Valuation by Aid of Specific Gravity.—When the same materials are used, and so long as the conditions of the manufacture remain the same, the specific gravity of the masses of ferro-aluminum made bears a definite relation to the quantity of aluminum contained, the specific gravity is inversely proportional to the amount of aluminum contained. As the raw products vary but slightly in the same class of goods, differences of physical condition need only be taken into consideration, and these are rendered evident in the external appearance of the products, such, for instance, as separation of graphite. According to the process of manufacture of ferro-aluminum, the graphite separates from the mass and may be mechanically removed, or it remains evenly distributed in the mass; in the former case, a product is obtained free from graphite, and in the latter a product containing graphite, and so gray to blackish in fracture instead of white. The product free of graphite has, for the same amount of aluminum, a higher specific gravity than the other. In the compilation of empirical tables of the specific gravity and amount of aluminum, these points must be carefully noted.

Estimation of Small Quantities of Aluminum in Iron and Steel the author considers may be most easily and most quickly performed by the potassium cyanide method. The large quantities of reagents required, however, are apt to contain sufficient alumina to introduce considerable errors.

ALLOYS OF ALUMINUM AND COPPER.

These may be classed under three heads: (*a*) "aluminum bronzes," consisting for the most part of only aluminum and copper; (*b*) "aluminum brass," containing a third considerable constituent, zinc; (*c*) other combinations in company with copper. The most useful aluminum bronzes contain from 5 to 12 per cent. of aluminum, not more; if more than 19 per cent. be present, the alloy becomes brittle and unworkable. Silicon is often purposely added, as it increases the tensile strength; maximum is 2·5 per cent. A good idea as to the character of the alloy may be obtained from its outward appearance and physical properties. An alloy containing less than 3 per cent. of aluminum has almost the color of copper; with from 3 to 4 per cent. it has the color of a reddish sample of gold; with 5 per cent. the color is gold yellow, and with increasing percentage of aluminum the alloy becomes yellower, while with 15 per cent. of aluminum the color is white, with merely a tinge of red. Fracture gives also characteristic indications. Aluminum brass contains up to 3·5 per cent. of aluminum. Even 0·25 per cent. of aluminum has a very considerable influence on brass, raising the tensile strength. An alloy with 40 per cent. of zinc and 2 per cent. of aluminum has a high tensile strength, while with 40 per cent. of zinc and 3 per cent. of aluminum the alloy is brittle, but a great improvement is again noticed if the zinc be reduced to 33 or 34 per cent. For rapid valuation of these alloys, a specific gravity determination made in conjunction with a qualitative examination may be made to tell whether aluminum bronze or aluminum brass is present, and, if the former, what amount of aluminum and silicon it may be expected to contain. (These points are illustrated in the original article by a diagram.)

The author makes the following observations regarding quantitative estimations:

Silicon.—(*a.*) 3–5 grammes of material are dissolved in aqua regia, the solution is taken to dryness, and the residue is taken up with hydrochloric acid or evaporated with sulphuric acid. Should the residue be not perfectly white, it is fused with a mixture of sodium and potassium carbonates. (*b.*) Should tin or lead be present, nitric acid alone is used instead of aqua regia, evaporation being subsequently performed with sulphuric acid. The precipitate obtained in this way contains the silicon, the tin, and the lead. It is fused with sodium and potassium carbonates, and then evaporated with nitric acid. SiO_2 and SnO_2 form the new precipitate. The silica may subsequently be determined by evaporation with hydrofluoric and sulphuric acids.

Iron and Aluminum.—(*a.*) Zinc absent. From the original solution in aqua regia the copper is precipitated by sulphureted hydrogen or sodium thiosulphate, and then the iron and aluminum are separated in the filtrate by pouring the same into boiling caustic potash (after removal of sulphureted hydrogen, etc.) The cyanide method may also be used, but in this case the alumina precipitate generally contains a little copper. This may be removed, however, by boiling with dilute nitric acid, neutralizing with ammonia, and filtering the pure hydrate precipitated. The iron determination here must be made in a special portion of the solution by precipitating with ammonium hydrate, dissolving the precipitate in dilute acid, and titrating with stannous chloride, or, after reduction with zinc, titration may be performed with permanganate. (*b.*) Zinc present. The iron and aluminum are first precipitated together by sodium acetate or ammonium hydrate, and then separated as above in (*a*).

Copper.—Best done by electrolysis. 3–5 grammes of material are dissolved in nitric acid, a little sulphuric acid is added, and the whole is evaporated to a sirup. An aliquot portion (= about a gramme), diluted, is then electrolyzed. Before electrolyzing it is well to neutralize with ammonia and add 10 cubic centimeters of dilute nitric acid for 200 cubic centimeters of liquid. By taking this precaution complete precipitation is effected.

Zinc.—Most conveniently estimated electrolytically. Precipitation as phosphate is quick. Determination with potassium ferrocyanide is also very quick, and is sufficiently exact.

Manganese occasionally finds its way into bronzes. It is obtained in company with the iron in separation of iron and alumina by caustic potash.

* *Zeits. f. angew. Chem.*, through *Jour. Soc. Chem. Ind.*

FERMENTATION.

AT a recent meeting in London of the Pharmaceutical Society Prof. Armstrong delivered a lecture on the "Phenomena of Fermentation."

Professor Armstrong said the fermentation phenomena connected with the conversion of a substance like cane sugar into two glucoses, and the subsequent conversion of the glucoses into alcohol and carbon dioxide, essentially consisted of a series of hydrolytic changes. During the enzyme stage, when the cane sugar was converted into the two glucoses, the change was brought about by a non-vital action; but during what he had called the zymic stage, the change involving the formation of the alcohol and the carbon dioxide took place under the influence of a living cell, and was a vital action. In the first stage simple hydrolysis took place, and there was merely a resolution of the molecules into a simpler form; but during the zymic stage there was recurrent hydrolysis, and the molecules of ordinary alcohol and carbon dioxide were produced by the rearrangement of the oxygen and hydrogen atoms, in consequence of the localization of hydrogen in one part of the molecule and of oxygen in other parts of it. That was brought, no doubt, about by the action of water under certain conditions. There was nothing in any degree mystical about the action of those organisms, as they could imitate that action by means of such agents as ordinary milk of lime. The enzymic stage—the conversion of the cane sugar into the two glucoses—took place at a much greater rate than the conversion of the glucoses into alcohol and carbon dioxide.

If yeast be placed in a cane sugar solution, it would, within a short space of time, convert the whole of it into glucose. The explanation that the fermentation was due to electric hydrolysis was suggested by Baeyer in 1870, and there were far more precedents in the present day in support of this explanation than there were then. A great many cases are known to us now in which, by the action of water under the influence of either acids or alkalies, precisely similar changes might be brought about in substances of the carbohydrate type, and Baeyer's suggestion that there was merely a rearrangement brought about by the withdrawal of the elements of water and their readmission in a new order was a perfectly satisfactory explanation from our present point of view. He suggested that there was an electric hydration and dehydration—that the elements of water were withdrawn and then added on in a different order; but he offered no suggestion as to the way in which the action might be brought about. He (the lecturer) had pointed out that it was not necessary to assume that there ever was any actual separation of the elements of water from the molecule and their subsequent readmission, and had shown that the action might be brought about by a kind of electrolytic change taking place locally within the molecule. In a galvanic cell there might be the liquid with the two plates in it, but of course nothing would take place until they made the circuit by uniting the plates outside the liquid; and in the phenomena they were considering the organism practically did nothing more than make possible the formation of the circuit. Although it had not been absolutely stated by Pasteur in so many words, there was very little doubt that he looked upon fermentation as pathological phenomena. He took the view that the conversion of glucose into alcohol and carbon dioxide took place when the organism was living in an atmosphere free from oxygen, but that it was necessary for the life of the organism that it should have hydrogen at its disposal, and when it could not get atmospheric oxygen it set to work to get it from the sugar molecule.

That explanation did not, however, satisfy the modern chemist. Pasteur based this theory on experimental observations, but there was no doubt the facts were not quite as he thought they were. He thought that fermentation did not take place in presence of oxygen, that oxygen prevented it, but it was now known that such was not the case. Yeast was one of those organisms apparently which was not affected by oxygen. So far as we know at present fermentation goes on briskly in the presence of oxygen, which, in fact, rather favors it than otherwise. Pasteur's view was based on certain experiments which seemed to show that fermentation, which did not otherwise take place, took place when oxygen was withdrawn. He describes experiments with ripe fruit in which they were taken and put in an atmosphere of carbon dioxide, when it was found that alcohol was produced in considerable quantity; and he came to the conclusion that the living cell of the fruit set to work and brought about the formation of sugar and the other changes. Those experiments, however, could not be considered satisfactory, as it was impossible to properly sterilize the fruit. The surface of the fruit was covered with organisms, and whatever care might be taken, it was pretty clear that they could not be killed so as to prevent their acting and vitiating the experiment. Until that experiment had been repeated, in such a way as to satisfy modern requirements, he should not attach much importance to the conclusions drawn from it. Alcoholic fermentation was a purely analytical process. The sugar molecule was simply taken to pieces and resolved into simpler elements; and that was true also of lactic fermentation.

The text books had got a way of saying that lactic fermentation involved the resolution of the sugar molecule into two lactic molecules; but lactic acid was not the only product of lactic fermentation, and there was nothing to justify the statement that the sugar molecule was simply resolved into two lactic molecules. Bacterial fermentation generally gives rise to products which bear a far less simple relation to the original substance. Lactic acid is converted under the influence of an organism into butylic acid, and glycerol is converted by a particular organism into normal butyl alcohol. The formation of butylic acid from lactic acid is similar in character to that which is involved in the formation of fats from carbohydrates in the animal organism.

Sugars which contain a large amount of oxygen are converted into fats which contain very little oxygen indeed. Butylic acid contains relatively very little oxygen when compared with lactic acid. The bacteria have the power of taking the oxygen from the water and liberating a large part of hydrogen. Their action is that of an oxidizing agent. By the action of the organism compounds are formed capable of acting upon one another, leading to the formation of compounds, which in turn can undergo fermentation. These compounds are exceedingly sensitive to the action of oxidizing agents. The tendency of hydrogen to become liberated is very strong, because there is an enormous desire on the part of two atoms to unite and form a hydrogen molecule. There is every reason to think that the affinity of like atoms, such as hydrogen for hydrogen, and oxygen for oxygen, is very great. There is a strong desire on the part of the hydrogen atoms to get away in each other's company, and in that way there is no difficulty in accounting for the currents of changes taking place in these phenomena of fermentation.

When we make spirit in the ordinary way, we do not get a pure spirit, but there is a good deal of high boiling products. Fusel oil, which is a complex mixture, contains sometimes propyl alcohol, hydrobutyl alcohol, and amyl alcohol. Those alcohols have one thing in common, that one of the carbon atoms is associated with two others. In the dextrose formula we have a simple chain of carbon atoms, so that clearly in the formation of amyl alcohol by fermentation a change is brought about, of a different character to those we have been dealing with, in which there was merely a rearrangement of the oxygen and hydrogen atoms. These amyl alcohols are not products of alcoholic fermentation proper. There is reason to believe that heat does not give rise to fusel oil, but that fusel oil is due to bacterial fermentation. Another class of fermentation is brought about by the influence of a great variety of moulds and of that organism so useful to the vinegar maker. Vinegar is made by trickling alcohol through a vessel over a surface usually of wooden shavings. So long as those shavings are clean no effect is produced, but it is found after a time that a growth takes place in these shavings, and that under the influence of these organisms the alcohol becomes oxidized. The organism simply has the power of laying hold of atmospheric hydrogen and making use of it for the purpose of oxidizing the alcohol. It is an exceedingly interesting organism, because, although it has the power of oxidizing a great number of substances, it has its likes and dislikes. It has not the slightest effect on methyl alcohol, but it oxidizes propyl alcohol readily enough. It will not look at fusel oil, but it oxidizes glycol and also glycerine.

With regard to that great class of fermentations commonly called putrefactive, and which give rise to unpleasantly smelling substances, the bodies attacked are such as we know little about, and products ultimately

obtained are in no sense primary products of fermentation. The bacteria resolve the albuminoid substances into simpler substances, which undergo change in a variety of ways in consequence of their entering into combination with each other and of their being acted upon by hydrogen. These phenomena of fermentation of albuminoid substances are of special importance, owing to the recognition in recent years of the part which the organisms play in zymotic diseases. It is clearly recognized at the present day that the fatal effects are in consequence of poisoning by products of the fermentative changes which go on in the system under the influence of these organisms. It was long supposed that certain substances which had been isolated were the actual poisons, but recent results seem to show that the actual poisons have entirely eluded our grasp, and within the last two or three years there has been a sort of reaction against the idea that they were alkaloid substances and in favor of the view that they belong to the so-called peptone class—much more nearly allied to the albumens.

Unfortunately, up to the present time the evidence on record is of such a kind that it is practically impossible to give any opinion with regard to it. It was almost hopeless to expect much progress in this direction so long as we remained ignorant of the composition of the albuminoid substances which are acted upon. With reference to the selective action of these organisms, it was probable that by studying this we should get some kind of explanation as to the susceptibility of some persons and the non-susceptibility of others to certain diseases. All the substances which undergo fermentation are capable, when in solution, of rotating polarized light.

Lactic acid is a substance of that kind. That is true of all the carbohydrates and all the alkaloids. On looking at the formula of the lactic acid molecule, it will be seen that the carbon atom is associated with four different groups, and the idea is that all compounds of that kind in which there is present an azometric carbon are capable of rotating polarized light. This subject was of great importance with regard to the immunity from disease being conferred by certain substances. They knew that vaccination prevented smallpox, but up to the present they had not been able to form any idea as to the way in which it acts. If they took the liquid in which anthrax bacillus had grown and administered that to an animal, it protected that animal to a very considerable extent against the anthrax. In following that out in the future, a triumph of an astounding character might be achieved, and they might be able to produce substances capable of entering into combination with the human organism, and in some way or other of altering the composition of the tissues to a sufficient extent, so to speak, to turn the activity into other channels, and to secure immunity from certain diseases.

A RAPID METHOD OF DETERMINING THE COMPOSITION OF LUBRICATING OILS.

By HAROLD GRIPPER, F.C.S.

THE great majority of the oils now used for machine lubricating are mixtures of hydrocarbon and saponifiable oils. The existing methods for the determination of these constituents are accurate and easily worked, but somewhat tedious, all consisting in saponification and subsequent separation by extraction of the hydrocarbons with ether. The usual process (described in Allen's "Commercial Organic Analysis," vol. ii., p. 83) involves saponification, evaporation of the alcohol, dilution with water and cooling, separation in a separating funnel with ether, and finally evaporation of the ethereal layer and weighing of the residue. All this takes time, even if the separation in the separating funnel takes place rapidly, which is not always the case.

The following process I have found useful when a number of samples have to be examined at the same time, and when results approximately correct only are required, as is often the case in this laboratory. The results obtained are within 2 or 3 per cent. of the truth. The method is simply an extension of the well known Koettstorfer process. Two and a half grammes of the sample are saponified in the usual way with 25 c. c. of a solution of alcoholic potash about N/3 (with oils containing more than 50 per cent. of saponifiable oil the usual N/2 strength may be used). When saponification is complete the titration is made in the ordinary way with N/2 HCl, using phenolphthalein as indicator, and a blank experiment having been made to estimate the strength of the alcoholic potash used, the percentage of KHO used by the sample is calculated.

The saponifiable oils chiefly used in the making of mixtures for lubricating purposes are—

	KHO absorption.	Saponification equivalent.
Brown cotton seed....	22·27 per cent.	252
Brown rape.....	20·03 "	280
Neatsfoot.....	18·70 "	300
Lard.....	19·30 "	290
Tallow.....		
Castor.....	17·90 "	313

The potash absorptions therefore vary between 17·90 per cent. and 22·27 per cent. It is necessary to take the mean of these figures (20·08 per cent.) as the potash absorption of the unknown mixture of saponifiable matter in a lubricating oil. Then $100·0/20·08 = 4·98$ parts of the oil are saponifiable by 1 part of KHO. Therefore if the percentage of KHO absorbed by the sample be multiplied by 4·98, the amount of saponifiable matter present will be obtained. Or the calculation may be simplified by multiplying the number of c. c. of N/2HCl (corresponding to KHO neutralized) by $(0·02805 \times 40 \times 4·98) = 5·587$. The proportion of saponifiable oils is thus obtained. The amount of hydrocarbon oil is ascertained by difference.

But it is necessary to know the specific gravity of the hydrocarbon oils. In order to estimate this, the liquid in the oil flask is, immediately after titration, raised again to the boiling point, and poured through a filter paper which has been saturated with boiling water. The alcoholic solution of soap and KCl will run through in two or three minutes, the hydrocarbon oils remaining on the filter. They are washed once with boiling water, and the specific gravity may then be taken by Hager's method. It is not necessary to wash the oil more than once, since in making Hager's test the globule of oil dropped into the alcoholic liquid is immediately cleansed thereby from all impurities. The specific gravity of the hydrocarbon oils and of the original mixture being known, the specific gravity of the saponifiable oils may be calculated by difference.

By titration.	By separation and weighing.
I. 78·3 per cent of hydrocarbon oil, sp. gr. 0·891 21·7 " saponifiable oil, " 0·950	79·3 per cent of hydrocarbon oil, sp. gr. 0·890 20·7 " saponifiable oil, " 0·957
79·4 per cent of hydrocarbon oil, sp. gr. 0·891 20·6 " saponifiable oil, " 0·955	
78·3 per cent of hydrocarbon oil, sp. gr. 0·891 21·7 " saponifiable oil, " 0·959	
II. 72·7 per cent of hydrocarbon oil, sp. gr. 0·900 27·3 " saponifiable oil, " 0·973	74·4 per cent of hydrocarbon oil, sp. gr. 0·900 25·6 " saponifiable oil, " 0·979
III. 76·6 per cent of hydrocarbon oil, sp. gr. 0·882 23·4 " saponifiable oil, " 0·956	76·7 per cent of hydrocarbon oil, sp. gr. 0·883 23·3 " saponifiable oil, " 0·953
IV. 65·4 per cent of hydrocarbon oil, sp. gr. 0·887 34·6 " saponifiable oil, " 0·966	64·1 per cent of hydrocarbon oil, sp. gr. 0·886 35·9 " saponifiable oil, " 0·964
V. 79·9 per cent of hydrocarbon oil, sp. gr. 0·885 20·1 " saponifiable oil, " 0·963	
79·6 per cent of hydrocarbon oil, sp. gr. 0·885 20·4 " saponifiable oil, " 0·962	79·8 per cent of hydrocarbon oil, sp. gr. 0·886 20·2 " saponifiable oil, " 0·959
79·9 per cent of hydrocarbon oil, sp. gr. 0·885 20·1 " saponifiable oil, " 0·963	
VI. 56·5 per cent of hydrocarbon oil, sp. gr. 0·906 43·5 " saponifiable oil, " 0·966	58·2 per cent of hydrocarbon oil, sp. gr. 0·908 41·9 " saponifiable oil, " 0·965

This method an analysis may be completed, including the calculation of results, within an hour of the commencement of the saponification, and in examining a series it is of great advantage, a dozen samples being easily completed in a day. The only source of error is in the fact that the nature of the saponifiable oil, and therefore its exact saponification equivalent, is unknown.

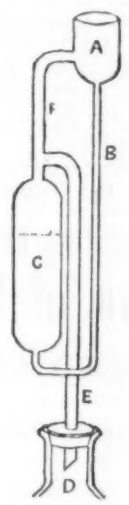
The accompanying results were obtained by the process described, and by the usually accepted method of separation with ether and weighing the hydrocarbons. The results are in all cases in approximate and in some cases in close agreement.—*Chemical News.*

FAT EXTRACTION APPARATUS.

By ALFRED SMETHAM, F.C.S., F.I.C.

SOME years ago I devised a form of fat extraction apparatus for solids on the principle of upward filtration, but as it presented no advantages over the now well known Soxhlet form, I did not deem it desirable to publish an account of it. A few months ago, however, I had occasion to extract some liquids with ether, and it occurred to me that the apparatus might be pressed into service for that purpose, and as it answered all my expectations, I modified it somewhat in form, and have now used it in my laboratory for some six months or so. As it has been very serviceable to me, I venture to give a description of it to the society, in the hope that it may be useful to others, more particularly as it is specially adapted to the extraction of fat by the Schmid process.

The working of the apparatus will be easily understood by a glance at the accompanying diagram. The



liquid to be extracted is poured into cup, A, so that the whole of it will run down the tube, B, into the bulb, C, which should not be more than about two-thirds full. About 5 c. c. of ether are poured into a tared flask, D, attached to the tube, E, by a cork in the usual way. The bulb, C, is then completely filled by adding ether carefully to the cup, A, and the whole is adapted to an upright condenser—as with a Soxhlet tube. When the flask, D, is immersed in hot water, the ether vapor passes along the tubes, E and F, is condensed in the Liebig's condenser and runs back by B into C, and rises drop by drop through the liquid to be extracted. The process is, therefore, continuous and automatic, and may be applied to any two non-miscible liquids, provided the solvent be the lighter.

To the public analyst it will, I apprehend, be chiefly of value because of its applicability to the extraction of fat from milk and its products; especially when treated by the Schmid process. For this purpose 10 c. c. of the sample under examination are measured or weighed into a little beaker, 10 c. c. of hydrochloric acid added, and the mixture gently boiled with constant stirring for two or three minutes. When cold, the mixture is poured into the apparatus as described and the beaker washed with ether and the washings added. The apparatus is then put together and the extraction allowed to proceed for an hour or so, when the whole of the fat will be found in the flask, D. As there is only a small quantity of ether with the fat, the flask may be placed directly into the water oven and the contents weighed to constancy in the usual way. The whole operation, so far as actual work is concerned, can be performed very rapidly and with great ease and accuracy, the only error entering into the process being, so far as I have been able to ascertain, the slight solubility of some caramel-looking matter, which contaminates the fat to the extent of a milligramme or two.

So far as my experience goes it appears that the extraction of the fat is more rapid the more perfectly the milk and acid have been boiled together. Thus, when boiled for three minutes, practically the whole of the fat is removed in half an hour, whereas, when only boiled for two minutes, in one instance, 31 milligrammes remained unextracted at the end of that time; while when boiled for one minute only about two-thirds of the total fat was extracted, the remainder being removed with difficulty. It would appear, therefore, that to readily extract the whole of the fat, it is necessary to boil the milk and acid together for some time, say three minutes.

The following results, obtained with four different samples of milk, and taken in this order, will give some idea of the accuracy of the process under varying conditions:

	Schmid. Boiled with HCl for one minute.	Two minutes.	Three minutes.	Five minutes.	Adams method. Extracted 3 hours.
1. Extracted 3 hours.....			2·60		2·49
2. " ½ "		3·01	4·49		
" 1 "		4·21	4·53		
" 1½ "		4·46	4·56		4·51
3. " ½ "		2·61	2·69		
" 1 "		2·75	2·75		
" 2 "		2·78	2·80		2·28
4. " ½ "	2·31			3·46	
" 1 "	3·31			3·51	
" 1½ "	3·49			3·56	
" 2½ "	3·61				3·57

The determinations by the Adams process were made by the use of Schleicher and Schull's fat-free paper, and the extraction was continued for three hours.—*The Analyst.*

BORON.

A PAPER upon the preparation of amorphous boron is contributed by M. Moissan to the current number of the *Comptes Rendus*. It was shown in a communication to the Academie des Sciences upon February 15 that the substance hitherto regarded as amorphous boron is a mixture of that substance with large quantities of impurities, formed by the combination of the boron at the moment of its liberation with a portion of the metal used to replace it and with the substance of the vessel in which the reaction is performed. M. Moissan now describes a method by which he has succeeded in obtaining boron in a state of almost perfect purity. The reaction which he employs is that of metallic magnesium upon boric anhydride, a reaction previously studied by several observers, and most recently by Prof. Winkler, who employed the magnesium in the quantity calculated to remove all the oxygen from its state of combination with the boron. M. Moissan shows that, if only one third of this quantity of magnesium is employed, the yield of free boron is very much enhanced, and the impurities are only such as can be removed. He confirms Prof. Winkler's statement that two borides of magnesium are capable of formation, one of which is unstable, and, as shown by Messrs. Jones and Taylor, is decomposed by water with evolution of a mixture of hydrogen and boron hydride, while the other is permanent both in the presence of water and acids. It is this stable boride, which M. Moissan has obtained in good crystals, which is so difficult to remove from the substance which has hitherto been considered as amorphous boron, and its formation should be avoided as much as possible. When magnesium and boric anhydride in the proportions above indicated—convenient quantities being 70 grammes of the former and 210 grammes of the latter—are heated to redness in a closed crucible, a somewhat violent reaction occurs, the crucible becoming vividly incandescent. Upon cooling, a reddish brown mass is found, which is readily detached from the crucible, and is impregnated throughout with crystals of magnesium borate.

The interior portion is then powdered, and successively treated with water and hydrochloric acid, alcoholic potash, hydrofluoric acid, and lastly with distilled water. This product, even after such exhaustive

treatment, upon drying *in vacuo*, is found to contain only 95 per cent. of boron. In order to remove the 5 per cent. of the stable boride, the product is again heated to redness in the midst of a large excess of boric anhydride, and the extraction and washing repeated as before. The percentage of boron is by this means raised to 98·3 per cent., the remaining impurity being a mere trace of the boride and 1·3 per cent. of nitride of boron. These remaining impurities have finally been eliminated by employing a crucible rendered impenetrable to the furnace gases, the nitrogen of which rapidly causes the formation of nitride, by means of a mixture of titanic acid and charcoal. In addition to the laborious method above indicated, by which tolerably large quantities of pure boron may be obtain d, M. Moissan further shows that it may be prepared in smaller quantities by the reduction of boric anhydride by magnesium in a stream of hydrogen, when, after extraction, a pure product necessarily free from nitride is obtained. And lastly, M. Moissan describes an electrolytical method of preparing it. Fused boric acid is rendered a good conductor of electricity by the addition of 20 per cent. of its weight of borax. Upon passing through the fused mixture a current of 35 amperes, a little sodium is liberated at the negative pole, and combines with the platinum electrode to form an alloy, while amorphous boron and oxygen are liberated at the positive pole. The greater portion of the boron, owing to the high temperature of the reaction, recombines with the oxygen with most brilliant incandescence, but a portion escapes combination, and may be isolated in the pure state as a chestnut-colored powder. —*Nature*.

PEDETIC MOTION IN RELATION TO COLLOIDAL SOLUTIONS.*

By WILLIAM RAMSAY, Ph.D., F.R.S.

PEDETIC motion of small particles depends (1) on the size of the particles; (2) on their density; (3) on the nature of the medium in which they are suspended. An electrolyte does not cause the motion to cease at once, but the particles cohere when they happen to touch, and ultimately form clots or clusters. If an electrolyte be not present, the particles do not seem to touch. From observations with the microscope, it is calculated that a particle with a mass of $2{\cdot}8\times10^{-12}$ grammes moves through approximately its own diameter $1{\cdot}4\times10^{-4}$ c.m. in a second. Such a particle has one hundred billion times the estimated mass of a water molecule; hence, if its motion be produced by bombardment from water molecules, these must exist in complex groups of considerable mass and of some stability. It is very unlikely that pedetic motion is the result of electric charges on the particles, because they appear to be uninfluenced by each other's motion; there is no obvious source of such electric potential; and, moreover, we know from Messrs. Linder and Picton's experiments the result of electrifying them; they are repelled from the positive or negative pole, according to their nature; but their pedetic motion is not interfered with, and is quite different in kind from the flow from the pole. An explanation of this repulsion has been given by Quincke (1861) and by Clausius (1879). The fact that pedesis is stopped by the addition of an electrolyte would appear to show that the water complices are disintegrated by the presence of ions; it may be that the individual water molecules are attracted by one or other ion, or by both.

The effect of pedetic motion in a liquid is to cause hydrostatic pressure; such hydrostatic pressure would be less on a membrane capable of penetration by the molecular aggregates or particles; and as the suspensions examined by Messrs. Linder and Picton and the colloids investigated by Graham will not pass through porous clay, they must exert pressure on its surface; the water having fairly free ingress and egress, due probably to the disintegration and the reformation of molecular complices.

From actual observation of pedetic motion under the microscope, it cannot be doubted that the relative velocity of two particles depends on their mass; and if their volumes are approximately equal, the less dense particle moves much more actively than the more dense. It would appear not in the least unlikely that equal numbers of equally sized particles would exert equal pressure, as in the case of gases.

In an article by Lothar Meyer (*Kgl. preuss. Akad. d. Wissensch.*), on osmotic pressure, he points out the great discrepancy observed between all measurements of osmotic pressure (except those of Pfeffer on sugar), and the pressure calculated on the supposition that the space was filled with a gas at the same temperature; in all cases the observed osmotic pressure is too low, if it be supposed that ionization occurs. There are three possibilities: (1) The so-called semi-permeable membrane acts as a sieve, and is quite impermeable to molecules over a certain volume; (2) the membrane is not impermeable, but allows molecules of different momenta to pass at different rates, as with gases of different densities and porous clay; and (3) there is combination of the dissolved substance with the membrane walls, transference through and dissociation of the compound at the interior surface of the walls, as with hydrogen and a palladium diaphragm. Tammann has shown the great probability of the truth of the last hypothesis.

I am disposed to conclude that solution is nothing but subdivision and admixture, owing to attractions between solvent and dissolved substance accompanied by pedetic motion; that the true osmotic pressure has, probably, never been measured; and that a continuous passage can be traced between visible particles in suspension and matter in solution; that, in the words of the old adage, *Natura nihil fit per saltum*.

IRON RUST.

PROF. A. LIVERSIDGE, University of Sydney.—It was usually stated in books upon chemistry, he said, that iron rust consisted of the hydrated sesquioxide of iron; but on examining a very large number of specimens of rust from very many different places, and from iron articles of various kinds, and formed under very varied conditions, he found that in almost every instance the rust contained more or less magnetic oxide; in fact, in some cases the rust, although presenting the usual "rust brown" color and appearance, was, when powdered, practically wholly attracted by the magnet. The specimens which first drew his attention to the subject were some large scales of rust obtained from the rails of an old tramway at Clifden Springs, in Victoria, and he was led to collect and examine these on account of their resemblance to the crust so often present on metallic meteorites. On crushing this rust in a porcelain mortar and testing it with a magnet, it was found to be practically wholly attracted, the small quantity of iron magnetic oxide present being mechanically inclosed, lifted and removed by the magnetic particles (in consequence of the magnetic particles being joined end to end, parallel to the lines of magnetic force and forming a mesh work inclosing the non-magnetic matter); but by repeatedly applying the magnet, and especially under water, the magnetic powder was fairly well separated from the non-magnetic powder. Bright iron wire, plates, rods, nails, etc., were artificially rusted in many ways with free access of oxygen, and in almost every instance a large amount of magnetic oxide was formed.

* Lately read before the Chemical Society, London.

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